SCIENCE ABSTRACTS

Section A.—PHYSICS.

OCTOBER 1920.

GENERAL PHYSICS.

1218. *Interference Comparator for End-Measures.* **F. Göpel.** (Zeits. Instrumentenk. 40. pp. 3–15, Jan., 1920.)—A mercury-vapour lamp, with a filter, passing a known wave-length of light, sends its rays to a parallel-sided gap between a steel face and a glass face. Interference bands are thus formed. The distance between the faces and the consequent interference band system is dependent on the length of various end-measures introduced into a measuring machine of the usual type, first used by Whitworth. The light passes axially through the micrometer screw system, which is hollowed for the purpose. This instrument is installed at the Reichsanstalt, Berlin, for use in the highest class of measurement. The results can be expressed accurately to the one-fortieth of a micron. P. E. S.

1219. *Straight-Line Scale with Equidistant Divisions for Measurement of Angles.* **L. Barbillion** and **M. Dugit.** (Comptes Rendus, 170. pp. 1376–1378, June 7, 1920.)—Proposes the use of an equally divided scale on a straight arm movable over a curve having the form of an Archimedian spiral for the precise measurement of angles. The relation between the angle moved through by the arm and the linear distance between the joints of its intersection with the spiral at the beginning and end of its motion is one of direct proportionality. Alternatively, the pointer may be immovable and the curve marked on a dial capable of rotation. Other modifications of the proposal are described in the paper, J. W. T. W.

1220. *An Ultra-Filtration Apparatus.* **R. Gans.** (Ann. d. Physik, 62. 4. pp. 327–330, June 17, 1920.)—Bechhold has already described a process of ultra-filtration by means of a collodion and gelatine filter, and thereby discovered the influence of jelly concentration on the permeability of the filter. By this process it is possible to retain ultra-microscopic particles upon the filter while allowing crystalloids to pass through, and this affords a separation method much more rapid than dialysis. In addition, the gelatine concentration may be so varied as to differentiate between the sizes of particles. The object of the present paper is to describe the arrangement and mode of preparation of ultra-filters, which, while similar in principle to the Bechhold process, are essentially more simple, and render the method more accessible to general laboratory use. The process has been utilised [see Abs. 1199 (1915)] for the ultra-filtration of colloidal metallic solutions, the objective being the determination of geometric form and particle separation according to size. Villegas has also filtered hæmoglobin solutions, suspensions of albumen, milk, etc., and in this way obtained liquids free from particles. A photograph and diagram of the apparatus are included in the text. H. H. Ho.

1221. *Determination of Longitude by Wireless Telegraphy.* **R. A. Sampson.** (Roy. Astron. Soc., M.N. 80. pp. 659–669, May, 1920.)—In this paper the author examines what the use of wireless telegraphy for the determination of longitude involves, and gives some indication of the instrumental position. An outline is given of the organisation the research would require, and the co-operation outside of astronomical resources which would be needed if any complete treatment is attempted, is discussed. A. W.

1222. *Diffusion through a Rubber Membrane.* **H. A. Daynes.** (Roy. Soc., Proc. 97. pp. 286–307, June 1, 1920.)—There are two theories of the process of diffusion of gases through rubber—(1) that the effect is one of diffusion in the substance of the rubber, so that the thickness of the membrane is of importance, and (2) that the permeability of a membrane is independent of its thickness over wide limits. The paper describes in detail a method of measurement of the rate of flow of hydrogen and other gases, through rubber membranes of thicknesses varying from 0·3 to 1·4 mm. As a result of the tests it was found that the rates observed agreed with the assumption of a simple process of diffusion within the rubber and a negligible surface resistance. The mean value found for the diffusion constant was $11\cdot4 \times 10^{-6}$ cm. sec. at 20° C. The mean value of the absorption coefficient was 0·03 at 760 mm. and 20° C. This latter coefficient has a low temperature variation and is not responsible for the great variation of permeability with temperature. J. W. T. W.

1223. *Thermal Change of the Elastic Properties of Nickel Steels.* **P. Chevenard.** (Comptes Rendus, 170. pp. 1499–1502, June 21, 1920.)—Gives the results of experiments carried out on the coefficient of variation of the modulus of torsion on a series of 28 alloys. In the case of reversible steels, the coefficient shows a rapid increase to a maximum which corresponds to the minimum of dilatability, and then a gradual diminution. Irreversible steels do not show this anomaly. The value of the modulus of torsion is lowered by tempering and by hammer hardening, but is increased by the temperature of annealing and has a maximum between 450° and 550° and a limit at about 600°. C. O. B.

1224. *Miscellaneous Notes on Impact Tests.* **A. Ono.** (Kyushu Imp. Univ. Coll. Eng., Mem. 2. 1. pp. 89–116, 1920.)—An error of ±0·1 mm. in the notch hole of a mild steel test-piece to be broken in the Charpy machine of 4 mm. diameter may give rise to an error of ±1·5%, which is considered to be insignificant. The relationship between the work, A, spent in breaking the test-piece, and the diameter of the hole, d, is of the form $A = K + nd$. In mild steel specimens which show a banded

V.2
192

structure the irregularity found in notched-bar impact tests is probably due to the local concentration of the less plastic material, owing to the presence of phosphorus and non-metallic impurities. The restoration of toughness lost by cold strain was in the case of a material with 0·065% carbon effected by annealing at 600° C. At rather higher temperatures, however, a more brittle condition was induced, but at 900° C. the toughest condition was found. Some observations on grain-growth induced in strained dead-mild steel are included. At 700° C. and 800° C. grain-growth took place, but at 900° C. and 950° C. a fine-grained material was found. F. C. T.

1225. *Resistance of Silk and Linen to Heat and Radiations.* **L. Vignon.** (Comptes Rendus, 170. pp. 1322–1324, May 31, 1920.)—Ribbons of silk and of linen, lightly stretched, were exposed to sunlight behind windows or to heat for 45 days (in June and July) under different conditions: without previous treatment; dried at 100°, and then heated to 60° or 65° while exposed in a moist, hot atmosphere; with or without exposure; or in the dark. The specimens were also exposed in the various conditions to the radiation of a quartz-mercury lamp (Heraeus) for 24 to 76 hours, at distances of 0·10 m. and sometimes 0·30 m. from the quartz lamp. The observations confirm the view that animal tissues resist the influence of radiations better than vegetable tissues, so far as visible changes and tests of breaking strength indicate. H. B.

1226. *Springfield Rifle and Leduc Formula.* **A. G. Webster.** (Nat. Acad. Sci., Proc. 6. p. 289, June, 1920.)—One of the formulæ of internal ballistics found most useful, at any rate by practical ballisticians in the United States, is the formula of Leduc, which is $v = as/(b + s)$, thus giving the velocity v of a shot in the bore of a gun in terms of the distance s travelled by the shot. The graphical representation of this formula is a rectangular hyperbola. The mode of deducing the formula is decidedly open to criticism, but it turns out that for the Springfield rifle, the Leduc formula answers very well indeed. If v be in metres per sec. and s in cm., the formula for the rifle in question is practically $v = 1133s/(19{\cdot}8 + s)$. E. H. B.

1227. *Nuclear Constitution of Atoms.* **E. Rutherford.** (Roy. Soc., Proc. 97. pp. 374–400, July 1, 1920. Bakerian Lecture).—The subject is introduced by referring to the early attempts to account for the scattering of α-particles through large angles in traversing thin sheets of matter. Such attempts led the author to the conception of atoms with a central core, or positively-charged nucleus. From "scattering" data it was possible to deduce the approximate dimensions and charge carried by this nucleus. On this basis Bohr developed his spectrum theory for hydrogen and other light gases. Moseley, in his remarkable X-ray researches, showed that the atomic number of an element was an actual measure of its nuclear charge. Experiments are now in progress at Cambridge to confirm this result with greater accuracy.

In the present paper the author discusses in detail some experiments which have recently been made with a view to throwing further light on the constitution and stability of the nuclei of some of the simpler atoms. The dimensions of the nuclei are shown to be of the order 5×10^{-13} cm., and in close collision the nuclei come nearly in contact and may possibly penetrate each other's structure. Reference is made to earlier papers [Abs. 912 (1919)] in which long-range particles are produced when α-particles are fired into nitrogen. The problem has more recently been investigated in different ways—a magnetic deflection method of analysing the particles being of special interest. The novelty of the new method lies in the use of wide slits through which the stream of deflected particles passes on its way to the scintillating screen. The results now obtained confirm those previously stated (*loc. cit.*). The amount of disintegration effected in nitrogen by α-particles is shown to be extremely small, probably only one α-particle in 300,000 being able to get near enough to the nitrogen nucleus to liberate an atom of hydrogen with sufficient energy to be detected by the scintillation method. Even if the whole α-radiation from 1 gm. of radium were absorbed in nitrogen gas, the volume of hydrogen set free would be only about 1/300,000 of the volume of helium due to the collected α-particles, namely, about 5×10^{-4} mm.^{3} per year.

A brief account is given of experiments with solid nitrogen compounds. Since the liberation of hydrogen particles from nitrogen is a purely atomic phenomena, it was to be expected that similar particles would be liberated from nitrogen compounds in number proportional to the amount of nitrogen. To test this point and also the nature of the particles, a number of compounds rich in nitrogen were examined (boron nitride, sodium nitride, titanium nitride, and *para*-cyanogen). The results of such experiments indicate the probability that the H-atoms liberated from these substances when bombarded by α-particles originate mainly, if not entirely, in the nitrogen, although in the case of *para*-cyanogen part of the effect is suspected to be due to the presence of some hydrogen compound.

A similar investigation is outlined relating to short-range particles from oxygen and nitrogen.

The paper concludes with a discussion of the constitution of nuclei and isotopes, based on experimental results recently obtained; special attention is given to the structure of carbon, oxygen and nitrogen nuclei.

A. B. W.

1228. *Crystalline Structure of Zinc Oxide.* **W. L. Bragg.** (Phil. Mag. 39. pp. 647–651, June, 1920.)—Results are given of the careful X-ray measurement of the crystal structure of zinc oxide. This substance crystallises in the hexagonal system; the crystals being of the dihexagonal polar type, with an axial ratio of $a : c = 1 : 1\cdot608$. Natural crystals of zinc oxide, or zincite, are rare, the author using a "platy" mass of zincite of irregular shape for the present investigation. The reflection of the X-rays for certain carefully prepared faces was examined with the X-ray spectrometer, an antikathode of palladium being employed. The results indicate that the atoms of zinc are arranged on two hexagonal space-lattices, their centres corresponding very closely with those of a set of equal spheres in hexagonal close-packing. For a close-packed hexagonal arrangement of equal spheres, the axial ratio may be calculated to be $a : c = 1 : 1\cdot632$. The axial ratio in the case of zinc oxide is $a : c = 1 : 1\cdot608$. The positions of the zinc atoms are identical with those of the hexagonal close-packed arrangement of spheres, if the latter be supposed to contract in the direction parallel to the hexagonal axis so as to reduce the ratio c/a from $1\cdot632$ to $1\cdot608$.

The oxygen atoms are light compared with the zinc atoms, and the spectra cannot be held to determine their positions exactly. In so far as they do this, they are in agreement with the supposition that the oxygen atoms are on two hexagonal space-lattices identical with those on which the zinc atoms are situated, and derived from these latter by a movement of translation parallel to the *c*-axis, which brings every oxygen atom into the centre of four zinc atoms arranged at the corners of what is very nearly a regular tetrahedron.

An examination of cadmium sulphide CdS, and murtzite ZnS has also been made.

ZnO	$a : c = 1 : 1{\cdot}608$
ZnS	$a : c = 1 : 1{\cdot}635$
CdS	$a : c = 1 : 1{\cdot}622$
Close-packed structure	$a : c = 1 : 1{\cdot}632$

W. W. B.

1229. *Constitution of the Elements.* **F. W. Aston.** (Nature, 105. p. 547, July 1, 1920.)—In continuation of previous work [Abs. 721 (1920)] further experiments on mass-spectra have been made, the results of which may be summarised as follows:—Boron (atomic weight 10·9) is a complex element. Its isotopes are 10 and 11, satisfactorily confirmed by second-order lines at 5 and 5·5. Fluorine (at. wt. 19·00) is apparently simple, as its chemical atomic weight would lead one to expect. The results obtained with silicon (at. wt. 28·3) are somewhat difficult to interpret, and lead to the conclusion that this element has isotopes 28 and 29, with possibly another 30. Bromine (at. wt. 79·92) is particularly interesting, for although its chemical atomic weight is so nearly 80, it is composed of approximately equal parts of isotopes 79 and 81. Sulphur (at. wt. 32·06) has a predominant constituent 32. Owing to possible hydrogen compounds the data are as yet insufficient to give a decision as to the presence of small quantities of isotopes of higher mass suggested by the atomic weight. Phosphorus (at. wt. 31·04) and arsenic (at. wt. 74·96) are also apparently simple elements of masses 31 and 75 respectively. No line given by any of the above elements shows any measurable divergence from the whole-number rule. A. W.

1230. *Electrostatic Potential of the Fluorspar "Lattice."* **E[lisabeth] Bormann.** (Zeits. f. Physik, 1. 1. pp. 55–56, 1920.)—Landé [Abs. 529 (1919)] has calculated the electrostatic potential of the elementary grating of fluorspar. The author now states that Landé's value is incorrect, and makes a new determination (on theoretical grounds, of course) for the four compounds CaF_2, $CaCl_2$, $CaBr_2$, CaI_2. A. B. W.

1231. *Atom-Models.* **A. Smekal.** (Zeits. f. Physik, 1. 4. pp. 309–319, 1920.)—A theoretical discussion of various theories of atomic structure, with special reference to the work of Rutherford, Bohr, and Sommerfeld. A. B. W.

1232. *Ultra-microscopic Studies. Methods for the Determination of Shape of Sub-ultra-microscopic Particles.* **R. Gans.** (Ann. d. Physik, 62. 4. pp. 331–357, June 17, 1920.)—A particle is termed sub-ultra-microscopic when its dimensions are small with reference to the wave-length of light. When a plane linear polarised light-wave is incident on such a particle, the optical field is disturbed. Within the particle the electric field may be regarded as quasi-statistic, and if the dielectric constant of the particle and its surrounding medium are known the new field may be calculated. Such calculations can only be practically accomplished for quite special cases of simple shape, *e.g.*, the ellipsoid. Important conclusions, however, may be deduced for any desired form. Section 1 of the present paper deals with the principal electromagnetic axes. Depolarisation of the Tyndall light by non-metallic particles is studied in Section 2. It is found that the depolarisation, for the case of ordinary incident light, is double that with linear polarised light. Details with diagram of an apparatus for the measurement of depolarisation are given in Section 3. In Section 4, depolarisation of Tyndall light produced by metallic particles receives attention, and six tables of data are included. The optics of the silver micron are investigated in Section 5, while an experimental determination of its shape is described in Section 6. The assumption of an elongated ellipsoid of rotation is found experimentally to be correct and in accord with earlier absorption measurements. H. H. Ho.

1233. *Fluid Analogue to Ether.* **G. Green.** (Phil. Mag. 39. pp. 651–659, June, 1920.)—Recent observations show that in strong gravitational fields the ether may act as a slightly refracting medium and a material analogue may bear on the solution of ether problems arising therefrom. Consider the velocity u of a wave of length $2\pi/m$ in water of depth h given by the known equation $u = \sqrt{\{(g/m + \mathrm{T}m) \tanh mh\}}$, where T is the surface tension. Hence there will be a minimum velocity associated with a critical wave length given by $m^2 = g/\mathrm{T}$ for very deep water, and increasing as the depth decreases, while for a depth less than about 1/2 cm. there will be no minimum velocity. For h small but above this value, the water will transmit waves of length exceeding the critical value at almost constant speed equal to the limiting speed, $\sqrt{gh}$, of a long wave in water of depth h, and also transmits a certain stress between floating solids. Thus long waves in shallow water correspond to electromagnetic waves in ether, surface tension stresses correspond to gravitation stresses in the ether. Both gravity and surface tension are concerned in the water-wave propagation, the effect of the latter predominating in case of short waves and vanishing in case of long waves. May not the same occur in the case of ether waves, the gravitational ones being shorter than any yet observed? A plane wave passing the edge of a solid floating in shallow water will undergo change in speed owing to surface tension giving rise to a change of depth, and become bent, as occurs with light waves in a strong gravitational field. On the basis of the analogy, the constant light-speed would be a minimum speed and a definite relation would be anticipated between light-speed, the elastic constant or density of the ether, and the gravitation constant. The ordinary laws of reflection and refraction are obeyed by shallow water waves in a fluid otherwise at rest and all Doppler-effect phenomena will obtain. Dispersion and refraction of luminous waves would be much more completely parallelled if the matter were regarded as a portion of space permeable by the fluid containing a multitude of vibrators with periods of their own; there would, moreover, be a certain convection of the fluid in the vibrator region, and a convection coefficient has been obtained agreeing with that required by Lorentz's 1895 luminous wave theory. Lorentz showed [Arch. Néerland. 21. p. 103, 1896] that the ether, if compressible in accordance with Boyle's law and subject to gravity, would have no motion relative to the earth, and the resulting condensation around gravitating bodies would account for the observed light deflection. A close general similarity is traced between the apparent increase of inertia of bodies moving in a fluid and the corresponding apparent increase of inertia of electrons moving through the ether at speeds increasing up to, and equal to, the speed of light. The X-rays show the existence of ether waves of large amplitude arising from the motion of particles moving at the speed of light, corresponding closely to those arising in water from the motion of solids moving at the minimum wave speed. If light-speed be really a minimum wave speed in the ether, then the apparent inertia changes in electrons at speeds approaching it, and the behaviour of the X-ray pulses would be indications of motion relative to the ether and so present an avenue of escape from relativity. Otherwise there is nothing in the analogy inconsistent with relativity, and an apparent change in gravitational action on a body with accelerated motion through the ether would be anticipated just as accelerated motion of a body on the surface of a fluid would involve change in the apparent attraction between it and other bodies, owing to surface tension. G. W. DE T.

1234. *Introduction of a Rational Coordinate System into the Einstein Theory of Gravitation, and the Gravitational Field of a Heavy Sphere.* **G. Mie.** (Ann. d. Physik, 62. 1. pp. 46–74, May 20, 1920.)—The Einstein gravitational theory involves the peculiar difficulty that the ordinary practical definitions of the straight line and unit of length become untenable. The practicability of the whole of geometry depends on the existence of unchangeable bodies which can be used at different places and times as scales. In like manner constant physical processes (oscillations) are necessary for the comparison of time intervals. Such unchangeable measures for length and time, which are free from practical objections, depend ultimately on the constancy of the atom and the independence of its nature with respect to place and time. This introduction raises the question of the ether and empty space. On the ether theory, material particles are regarded as places in the ether in which enormous amounts of energy are concentrated into minute space, so that no absolutely unchangeable atoms exist. One of the most important problems, therefore, of the theory of matter, is to explain why material particles behave almost as permanent entities uninfluenced by their environment at least so far as experimental means can detect. This problem has been completely solved by Einstein so far as the gravitational field is concerned; whereby changes of material particles are alone determined by the gravitational potential. For the determination of correct values of length and time, the gravitational potential must be known, and a coordinate system must be evolved in which this potential is entirely expressed as a function of the space-time coordinates. Since this coordinate system cannot be arrived at by practical geometrical measurements, owing to the latter involving the assumption of inalterable atoms, an arbitrary numeration of the space-time point must first be given. According to the principle of general transformability, on which the Einstein theory is based, the fundamental physical equations are in the same simple form. An unsuitable choice of coordinate system, however, can produce apparent physical differences such as motions or waves which are not really based on objective facts but are entirely due to the choice of the particular irrational coordinate system. In this paper a rational system is described, whereby the practical determination of straight lines and their sub-division is attained without involving contradiction with reality. By this rational choice of coordinates, the author determines the gravitational field of a heavy spherical mass. The arbitrary constant, or the arbitrary function, which still occurs in the integral found by Schwarzschild, is determined as zero. Already Hilbert has proposed zero in place of Schwarzschild's assumed positive value, but only because the expression for the gravitational potential becomes simpler thereby. According to the author's method this integral is necessitated by the rational choice of the coordinate system. In order to obtain the Schwarzschild or indeed any other solution, the choice of the coordinate system must be based on a quite irrational non-Euclidean geometry. H. H. Ho.

1235. *Validity of Stokes' and Stokes-Cunningham's Formulæ.* I. *Hydronamical.* **J. Weyssenhoff.** (Ann. d. Physik, 62. 1. pp. 1–45, May 20, 1920.)—A general survey of the relevant considerations as to the limits within which the respective formulæ are valid. The paper contains no summary of conclusions reached. E. H. B.

1236. *Replacement of the Distribution (Ergoden) Hypothesis in Physical Statistics.* **R. v. Mises.** (Phys. Zeits. 21. pp. 225–232, May 1; and pp. 256–262, May 15, 1920.)—Paper I deals with general considerations. The transition from space to time totality has hitherto constituted the nucleus of difficulties arising in physical statistics. For their solution Maxwell and Botzmann introduced the distribution (Ergoden) hypothesis which lies at the basis, in one form or another, of every statistical-physical investigation. Ehrenfest has pointed out the unsatisfactory nature of the hypothesis, and stated that an explanation of the probability-idea is necessary for any further progress. The object of the present paper is to establish a physical statistical theory without recourse to the distribution hypothesis or any similar assumption. In its place only assumptions concerning the equal possibility of certain primitive cases are considered. In Part II the Brownian movement is discussed at length as an example of the general considerations advanced in Part I. Section 1 of the latter deals with the rôle of the distribution (Ergoden) hypothesis, Section 2 with the form of the new hypothesis, and Section 3 with its physical significance. Section 1 of Part II discusses virtual and space totality, Section 2 deals with time totality, and Section 3 with relationships to the mechanical hypothesis and to previous modes of treatment. The paper is philosophical throughout. H. H. Ho.

1237. *Vertical Temperature Distribution in the Lowest 5 km. of Cyclones and Anticyclones.* **W. R. Gregg.** (Monthly Weather Rev. 47. pp. 647–649, Sept., 1919.)—Observations have shown conclusively that while in Europe cyclones are colder than anticyclones at all altitudes in the troposphere except near the surface in winter, this is not true in the United States. Some observations made by kites at Mt. Weather and Drexel are classified and given in support of this. The difference is attributed (1) to the contrast between the continental climate of the United States and the marine climate of Western Europe so that, of the factors controlling temperature, the source of the air supply predominates in the United States, whereas in Europe this is of relatively smaller importance and radiation, pressure and vertical circulation are of relatively

V.2
192

greater importance, and (2) to the fact that systems move only two-thirds as quickly in Europe as in the United States which is said to give the effects of radiation, etc., greater opportunity for development. Further classification of the data according to rising or falling pressure shows that falling pressures with southerly winds have high temperatures, and *vice versa*. Additional evidence as to the greater control of temperature by the wind direction than by the surface pressure is given by the correlation coefficient 0·37 between the south component in the surface wind and the surface temperature at Drexel and 0·40 for the same at 3 km., while surface pressure gives with surface temperature −0·51 and with temperature at 3 km. −0·40. However, pressure at 3 km. gives with temperature at the same level the coefficient 0·66. M. A. G.

1238. *Low-Sun Phenomena in Luzon.* **W. J. Fisher.** (Philippine J. of Sci. 16. pp. 151–164, Feb., 1920.)—Various attempts have been made to set a lower limit to the height of the atmosphere by observing the time when the pale light of twilight first appears or disappears at the horizon. The present writer describes an endeavour to make a similar determination by noting the time at which the "dawn" passes the zenith. A pale light first spreads upwards from the east, followed by a blue. Observations of the "pale dawn" failed to give concordant results owing, amongst other things, to the uncertain relation of this phase to the zodiacal light. Fairly concordant results were, however, obtained by observing the time of appearance of the first tint of blue at the zenith. The observations extend over a year on moonless nights and give − 13° 38·′1 as the mean value of the sun's altitude, but the author regards the extreme value (−14° 46·7′) obtained as the most probable owing to certain conditions the effect of all of which is to postpone the time of observation. These altitudes yield 149·3 km. and 181·6 km. respectively as a lower limit to the height of the atmosphere.
M. A. G.

1239. *Zonal Variation of the Yearly March of Air Temperature.* **F. K. v. Marilaun.** (Akad. Wiss. Wien, Ber. 128. 2a. pp. 145–156, 1919.) *Zonal Variation of Temperature in Pure Land and Sea Climates.* **F. K. v. Marilaun.** (Akad. Wiss. Wien, Ber. 128. 2a. pp. 157–174, 1919.)—The mean monthly temperature of zones each comprising 10° of latitude, as given by Hopfner (Petermann's geogr. Mitt. 52, 1906), are analysed by obtaining the first three terms of Bessel's formula, this number giving sufficient approximation. Combining these terms, the times of maximum and minimum temperature for each zone are tabulated, together with the percentage of sea cover in each zone, thus bringing into prominence the tendency for greater lag with greater sea cover. The increase of yearly range of temperature with increased land cover is similarly exhibited and the relation is approximately linear if the range be divided by the latitude.

In the second paper the assumption often made, that with a water hemisphere the zonal temperature decreases as $\cos \phi$ and with a land hemisphere as $\cos^2 \phi$, is tested for such zonal temperatures, partly empirical, partly theoretical, given by various authors. This rate of decrease is not found in any case. For a water hemisphere a good fit is obtained by using the expression $\cos^m \phi$, m being a function of ϕ, not the same for all the authors. The form of m is, however, $a-b \cos \phi$ in three out of the seven cases examined, a being near 2 and b near 1. This indicates a decrease proportional to $\cos\phi$ at the equator and to $\cos^2\phi$ at the pole. For a land hemisphere the expression $\cos^m\phi$ is also found suitable, but only with three authors out of five does m indicate a greater rate of decrease than with a water hemisphere. M. A. G.

1240. *24-hour Barometer Oscillation in Relation to Surface Features.* **J. v. Hann.** (Akad. Wiss. Wien, Ber. 128. 2a. pp. 379–506, 1919.)—Deals with the geographical distribution of the amplitude and phase of the 24-hour barometer oscillation and the effect on it of local conditions. From observations on ships and small ocean islands, the universal 24-hour oscillation is found to be given at the equator by $0{\cdot}3 \sin(0°+x)$, the amplitude being in mm., thus having 6 a.m. maximum and a 6 p.m. minimum and differing in phase, as theory demands, by about 180° from the 24-hour temperature wave in the higher layers of the atmosphere. Beyond lat. 40° this universal oscillation becomes inappreciable or masked by that engendered by local surface features and differences of surface heating. This latter is studied by grouping coast and inland stations separately. Latitude is found to exert little influence on the phase, which in nearly all cases gives a night maximum between 6 p.m. and 6 a.m., but the amplitude tends to decrease with increasing latitude though not regularly. The amplitude is in general greater inland than on the coast, the average values being in low latitudes about 0·8 mm. and 0·6 mm. respectively. Stations on mountain slopes and summits are also considered, some of the greatest amplitudes being found here. Finally some outstanding types of daily-pressure curves are considered and their peculiarities traced to the 24-hour term and explained in the light of the results of the present paper. M. A. G.

V.2
192

1241. *Sea-level.* **R. A. Daly.** (Nat. Acad. Sci., Proc. 6. pp. 246–250, May, 1920.)—Examination of the levels of strand lines in a number of regions suggests a drop of the order of twenty feet in the ocean level in recent times. The evidence is so widespread that local deformations of the earth's crust could not have been responsible, and it is suggested that the withdrawal of water to form the polar ice caps, since the last warm interval, is the cause. W. A. R.

1242. *Seiches of Lake Geneva.* **A. T. Doodson, R. M. Carey,** and **R. Baldwin.** (Roy. Soc. Edinburgh, Trans. 52. pp. 629–642, 1919–1920.)—The paper is an application of J. Proudman's general solution for longitudinal seiches to Lake Geneva. The results of the calculation agree fairly with the observations of Forel on the Lake. The calculations are tabulated. W. A. R.

1243. *Eclipse Results and Contraction of Photographic Images.* **L. Silberstein.** (Roy. Astron. Soc., M.N. 80. pp. 630–631, May, 1920.)—F. E. Ross has measured the contraction of images with tanning developer, during the drying of the plates, due to the quicker drying of the tanned gelatine within and around the images, and the author now considers the possible effect of this on the eclipse plates, which have been shown to support the Einstein displacement theory. He admits that the contraction effect would be in the opposite direction, and probably too small to be appreciable, but thinks the possible distortions to be of more importance.

For double stars this Ross-effect will be more marked, and also for crowded spectrum lines. W. W. B.

1244. *Solar Eclipse of* **1922** *Sept.* **20.** (Roy. Astron. Soc., M.N. 80. pp. 628-630, May, 1920.)—This is a Greenwich paper dealing with the programme for a repetition of the Einstein test at the next favourable opportunity. It includes a field of the stars expected to be shown on the plates with their positions and computed displacements according to the theory; details of the instrument proposed for use, to obviate the defects of the cælostat as inferred from the Brazil results; and a short note on the probable conditions at the three convenient stations, Bandidu in the Maldive Islands, Christmas Island in the Indian Ocean, and an inland station, Cunnamulla, in Eastern Australia. W. W. B.

1245. *Shift of Fraunhofer Lines and Einstein Theory.* **J. Evershed.** (Engineering, 110. pp. 353–354, Sept. 10, 1920. Paper read before the British Assoc., Cardiff, Aug., 1920.)—Work on the shift of Fraunhofer lines has been going on at Kodaikanal Observatory since 1913, before it had come to be regarded as a crucial test of Einstein's theory. At first the intention was to study the effect of pressure on the shift. This effect, if any, is very small in the umbra of spots, but large displacements were found in the penumbra, and H and Ca lines showed radial movement outwards from the spot-centre. The pressure of 6 atmos. first assumed in the reversing larger seems manifestly impossible, so that the idea of pressure gives way to that of motion. Measurements of 136 Fe lines strongly support the idea of motion as against pressure. High-level lines showed larger shifts than low-level lines; pressure shifts strong in the laboratory were comparatively weak in the sun, and the average shift, which increases in the laboratory in the ratio of the square or cube of the wave-length, does not increase at all in the sun with wave-length.

For the S limb of the sun, the results agreed remarkably well with Einstein's prediction, but Ca and Mg lines showed smaller shifts than Fe lines, and displacement did not increase with wave-length as it should. Moreover, faint lines were more affected than strong ones, and the effect was not uniform across the disc. Therefore the author is inclined to refer the effects not to relativity, but to his tentatively suggested earth repulsion on the Fe vapour of the sun. He has tried to test this by observations of Venus when in front and behind the sun, but the evidence is inconclusive. W. W. B.

1246. *Enhanced Nitrogen lines in Region* H_β *to* H_ϵ. **A. Fowler.** (Roy. Astron. Soc., M.N. 80. pp. 692–696, June, 1920.)—A list is given of the brighter lines of nitrogen in the region specified. Of these 25 are ordinary lines and 20 enhanced; thus increasing the number of the latter noted by Lockyer, Baxandall and Butler [see Abs. 2018 (1909)], and to a great extent supporting the identifications of Lunt in respect of Nova Aquilæ [see Abs. 979 (1920)]. For a paper dealing with oxygen lines in this region see Abs. 948 (1917). W. W. B.

1247. *Einstein's Gravitation Theory and Shift of Solar Lines.* **E. Guillaume.** (Observatory, 43. pp. 227–228, June, 1920.)—The author here summarises a portion of the argument in his paper [Abs. 1123

(1920)] leading to the conclusion of an error prevalent in relativity discussions, concerning the use of the travelling clock. He observes that when one measures the same duration by means of several clocks with different periods θ, θ', . . . , the numbers obtained, t, t', . . . , are inversely proportional to the periods : $\theta t = \theta' t' = \ldots$. Now take the Lorentz transformation equation $ct = \beta(ct' + \alpha x')$, where c is the velocity of light, α a constant, αc the uniform velocity of translation of x' to x, and $\beta^2 = 1/(1-\alpha^2)$; and imagine a set of plane light-waves traversing both systems, ϕ' being the angle which they make with $\theta' x'$. Then the theory gives for the Doppler-Fizeau effect, $\theta = \theta'/\beta(1 + \alpha \cos \phi')$. Hence, since $x' = ct' \cos \phi'$, it follows that $\theta t = \theta' t'$ and $\theta dt = \theta' dt'$ . . . (1). Hence, it is argued, that dt and dt' cannot possibly be considered as periods as in Einstein's equation from which he deduces the displacement of the solar spectral lines, viz., $dt = dt'/\sqrt{g_{44}} = dt'(1 + \mathrm{GM}/\mathrm{R}c^2) > dt'$ . . . (2), G being the gravitation constant, M the sun's mass and R the sun's radius. Hence dt should be the period of a light source on the sun, and dt' the period of an identical source on the earth ; and since $dt > dt'$ light from the former should be redder than from the latter. But this is impossible, since dt and dt' are simply different measures of the same time. We cannot derive from (1) and (2) the relation $\theta' = \theta(1 + \mathrm{GM}/\mathrm{R}c^2)$, so that we have no right simply to put the term g_{44} apart from the quadratic form ds^2. **A. S. Eddington.** (*Ibid.*, 43. pp. 228–229, June, 1920.)—The author takes it that by the statement that dt and dt' are " simply different measures of the same time," Guillaume means that they differ numerically only because not measured in terms of the same unit. But in the latter form it seems to lack physical meaning, for time and length are only relations to some coordinate system. Two durations at different places, which are the same for one coordinate system will differ if another system be chosen. The quantities dt and dt' are the periods of the atoms referred to a rather arbitrary coordinate system which is chosen for mathematical simplicity, and so far the difference between dt and dt' could be regarded as merely an eccentricity of our coordinate system. Remembering that the coordinate system has been chosen so that the velocity of light at any point of the light wave does not involve the coordinate t, it follows that, dt remaining constant along the ray, the period dt' of the waves received in the laboratory is the same as the period dt at the sun. Therefore dt differs from dt'. Everything having now been brought into the laboratory, there is no further need for the coordinate system developed for describing the non-Euclidean conditions near the sun. Then transforming back to the limit of interval (ds), the same on the sun as on the earth, because an interval is an absolute quantity, we find that ds_1 differs from ds' ; it is this absolute difference that it is hoped to test spectroscopically. G. W. de T.

1248. *Displacement of Solar Lines towards the Red.* **A. H. Bucherer.** (Phys. Zeits. 21. pp. 451–452, Sept. 1, 1920.)—A discussion of the principle of equivalence leads to the conclusion that if the principle be accepted there must be a shift of solar lines towards the red. Calculation shows that the order of magnitude of this shift is the same as deduced by Einstein from the theory of relativity. A. W.

1249. *Displacement of Solar Spectrum Lines.* **C. E. St. John.** (Observatory, No. 554. pp. 260–262, July, 1920.)—In this short note a criticism is presented of the observations by Grebe and Bachem on the Einstein effect in the gravitational field of the sun. Various considerations relative to the means and method of observation and to the explanation of the results obtained lead to the conclusion that it is doubtful whether the results in question can be regarded as establishing the existence of the Einstein effect. [See Abs. 701 (1920).] A. W.

1250. *Motion of Solar System.* **F. Henroteau.** (Roy. Astron. Soc. Canada, J. 14. pp. 234–238, July, 1920.)—The suggested existence of stationary Ca clouds in interstellar space offers a fresh reference framework for the determination of the solar motion. Previous determinations differ according to the choice of a set of reference stars, most of which are moving. The B-stars, which move very slowly, are too distant for the purpose, as their proper motions are bound to be inaccurate.

The new proposal is for some observatory with a large reflector to devote it to the measurement of stationary K-lines where such are found, in order to obtain improved values of the solar motion. Refractors are less suitable on account of the absorption of the violet rays. W. W. B.

1251. *Distribution of Solar Faculæ.* **E. W. Maunder.** (Roy. Astron. Soc., M.N. 80. pp. 724–738, June, 1920.)—The author's wife pointed out some time ago [Abs. 1309 (1907)] a preponderance of spots, both in numbers and areas, on the eastern half of the sun. The present paper is similarly concerned with faculæ, and embodies a piece of work by members of the Solar Section of the British Astronomical Association.

The homogeneous part of the paper deals with the Greenwich results, 1886 to 1915 inclusive, but some earlier years have also been considered. The evidence from faculæ supports that previously obtained from spots and generally from prominences, that there is an effect of some kind which cannot plausibly be ascribed to the sun itself, and that this is very likely due to the earth. The eastern predominance is least marked during increase of solar activity, and most marked during its decline, so that if, as Mrs. Maunder suggested in 1907, the effect was that of a sort of " damping," the sun shows greater resistance to this damping effect when the general solar activity is increasing. W. W. B.

1252. *Radiation-Pressure in Solar Phenomena.* **A. S. Eddington.** (Roy. Astron. Soc., M.N. 80. pp. 723–724, June, 1920.)—Radiation-pressure, long ignored, has lately been invoked to an unjustifiable extent, and the author proceeds to suggest an upper limit to its possibilities. Using Abbot's value of the solar constant, he obtains a value for the pressure of the outgoing radiation of 2 dynes per cm.^{2} and finds that it cannot carry a total weight of more than 1 mgm. per cm.^{2}, and infers for prominence clouds a density less than 10^{-12}. For the corona to be supported by radiation-pressure its density cannot exceed 10^{-15}, which he considers improbable, though a similar density required for comet's tails if sent out by radiation-pressure, may be accepted. W. W. B.

1253. *Absolute Spectrophotometric Measures, with application to Solar Physics.* **G. Gouy.** (Ann. de Physique, 13. pp. 188–216, May–June, 1920.)—The author's plan is to give a complete account of results of investigations carried on by him and published fragmentarily in continuation of his Memoir on Coloured Flames (Ann. Chim. et de Phys., Vol. 18, 1879). He worked with flames formed by a mixture of air and illuminating gas, with a very small proportion of metallic vapour, being thus able to ignore the remote possibility of collisions between the very rare atoms of the metal. Thus l being the thickness of the flame and δ the density of the metallic vapour, the properties of the flame will depend on $q(=l\delta)$ as well as on the pressure, quality, and temperature of the illuminating gas. A second similar flame superposed will increase the brightness of the spectral lines h times, where h is 2 for very weak flames, but diminishes to a limiting value of 1·3. The author adopts conditions giving $h = 1{\cdot}9$ as standard for both q and i (intensity of spectrum lines), and gives a table of values for varying intensities in the case of the D line of Na. He gives details of his method, using a chamber of 46 m.^{3} capacity, a known weight of NaCl being volatilised and mixed with the air in the chamber, so that the density near floor and ceiling is approximately the same. A table of comparison for other elements, K, Li, Rb, Sr, Ca, Ba, shows that q has values of the same order for all. By varying q and comparing with the solar spectrum he finds the closest agreement when q is 2×10^{-10}.

He deals next with absolute measures of the brightness of bright and dark lines, and of the continuous spectrum of Na. His information about the continuous spectra of other elements is too scanty to allow him to assume similar behaviour for all; in fact, as far as experiments have gone, it seems that the simple explanation of all encounters as being between a metallic atom and one of the illuminating gas, though satisfactory for Na, is not true for the other elements. Therefore he feels bound to assume in the case of the sun a certain emissive power and absorption, of origin not strictly defined.

He objects to the idea that the sun must be surrounded by a layer of condensation clouds, forming the photosphere. He does not think anything but gaseous particles could exist at such a temperature, far higher than that of the electric furnace, which will volatilise all known substances. There only remains the exterior corona, which he thinks may not be entirely gaseous. A very small percentage of solid particles in suspension would suffice to produce the known spectroscopic effects.

Next, considering the temperature of various layers, he takes it for granted that the temperature increases with the depth, and finds that the brightness varies inversely with the emissive and absorptive power. Geometrically the depth must be greater near the limb, so that spots and pores appear darker, and faculæ, which are not deep, remain equally bright all over the disc, and consequently are better seen near the limb.

He discusses the relation between the flash spectrum and the reversing layer. He does not admit that gravity alone can explain the distribution, but assigns a thickness of 1000 km. to the layer producing the flash-spectrum, quite a different layer to that producing the Fraunhofer lines.

Finally, his figures yield for the layer producing the D line of Na in the centre of the disc, a value for the pressure of $4{\cdot}76 \times 10^{-13}$ atmo. Other values are found for the rays near the limb, where the effective layer is at a different depth. The pressure must be exceedingly small, as otherwise particles of heavier elements could not fall through an atmosphere so turbulent as that of the sun. His conclusion is, therefore, that the visible parts of the sun must consist of extremely rarefied gases. Thus the solar theory can be simplified by ignoring diffusion or refraction of light, which can have no appreciable effect. He rejects the laboratory experiments on which the "anomalous dispersion" idea is based, inasmuch as they could not be obtained at densities so low as that of the sun's atmosphere. W. W. B.

1254. *A Particular Case of Diffraction of Images of Celestial Bodies of Large Diameter.* **M. Hamy.** (Comptes Rendus, 170. pp. 1143–1149, May 17, 1920.)—In continuation of previous work, the author finds that n^2/m [see Abs. 203 (1920)] should have the value $\frac{1}{3}$, to give the best result for the limb of the sun. He claims that the sudden falling off of brightness near the limb is due to the observer and works out the best arrangement of telescope and slit to enable the true limb to be measured. W. W. B.

1255. *Photographic Parallax of Sirius.* **O. J. Lee.** (Roy. Astron. Soc., M.N. 80. pp. 632–633, May, 1920.)—By means of the double rotating sector at least twenty snapshots of Sirius are obtained during a five-minute exposure on the fainter surrounding stars. Fifteen photographs are used for the present determination of parallax, the positions of Sirius being first corrected for orbital motion. This is the first photographic determination and yields the definite parallax of $+0{\cdot}367'' \pm 0{\cdot}010''$. The period covered is 35 months and the deduced proper motion is $-0{\cdot}0364$ s. in R.A., as compared with Boss' $-0{\cdot}0366$ s.

The parallax agrees very well with Gills' heliometer determinations: 4-inch, $+0{\cdot}370'' \pm 0{\cdot}009''$; and 7-inch, $+0{\cdot}370'' \pm 0{\cdot}0097''$. Full details will appear in a Yerkes Observatory publication. W. W. B.

1256. *Proper Motions of Reference Stars in Greenwich Astrographic Catalogue.* **F. W. Dyson.** (Roy. Astron. Soc., M.N. 80. pp. 633–635, May, 1920.)—The proper motions of the stars in the third volume of the Greenwich Astrographic Catalogue have been determined by comparison with earlier catalogues, especially Lalande, Argelander and A.G. Catalogues, Christiania, Dorpat, and Kazan, the 1900 positions being well determined in Greenwich, Christiania II, Berlin C., and Hamburg catalogues, all reduced as far as possible to Boss' system. The proper motions have also been verified by comparing plates taken 20 years apart.

The results for stars between 65° and 81° N. declination are analysed with respect to type in seven classes, from B to M. There is a difference between the results from right ascension and those from declination, and several comparisons are made, in order to find an explanation. The differences between Boss and the Greenwich 1900 Catalogues and between the Greenwich, Berlin, and Christiania Catalogues yield expressions of the form $A + B \sin \alpha + C \cos \alpha$ with various values of the coefficients. Further comparisons with the results obtained with the Cookson zenith telescope at Greenwich, and between the results of above- and below-pole observations of declination, give similar expressions, but at present the best suggestion for reconciling the differences is that there may be a periodic error in the declinations of the Preliminary General Catalogue between 65° and 80° N., but the author is not disposed to press this without further examination of that region of the sky. W. W. B.

1257. *R Norma*, 152849. **W. M. W[orssell].** (Union Observat. S. Africa, Circ. No. 49. pp. 64–66, May 12, 1920.)—This variable shows double maximum and minimum. Nearly all the observations are suited by a period of 486·6 days; a few outstanding Cordoba observations in

August and September 1876 probably belong to a different star. The magnitudes at the four epochs are: 8·2 to 9·8, 6·8 to 7·5, 11·0 to 13·0, and 7·4 to 7·8. A previous Cape determination gave a period of 480·7 days, with magnitudes: 8·4, 6·9 to 7·4, 11·5, and 7·4 to 7·6 respectively. There is also a difference between the colour estimations. W. W. B.

1258. *Photographic Determinations of 46 Stellar Parallaxes.* **Z. Daniel** and **F. Schlesinger.** (Astron. J. 33. pp. 38–39, July 19, 1920.)—The parallaxes of these 46 stars were obtained with the Thaw refractor, and extend the Allegheny list from 319 to 365. The average probable error is 0·0081″. Full details will appear in the *Publications of the Allegheny Observatory*. W. W. B.

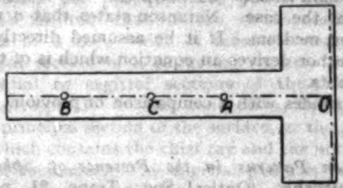
1259. *Nova Persei No.* 2. **E. E. Barnard.** (Roy. Astron. Soc., M.N. 80. pp. 710–722, June, 1920.)—Photometric observations are still continued on this star. The present paper contains those taken from December 1916 to March 1920. Careful comparison of the reference stars suggests that possibly two are variable and allowance is made for this. It is possible that the nova may be the nucleus of a planetary nebula. It seems now to have returned to its condition before the outburst. Though fainter at maximum than Nova Aquilæ, it started from a fainter stage, and its total increase of brightness was greater than that of Nova Aquilæ. The author also discusses the time taken by various other bright novæ to fade to their original faintness and also the different degrees of haziness shown by different novæ. W. W. B.

1260. *Measurement of Double Stars on Carte du Ciel Plates.* **H. E. W[ood].** (Union Observat. S. Africa, Circ. No. 48. p. 53, May 20, 1920.)—The use of the blink-microscope in comparing plates of the same region of sky at different epochs may show up an occasional case of orbital, relative, or common proper motion in a binary star. Most of them, however, appear single on the plates. The case of wide double stars is different, and the blink-microscope yields measures of such accuracy that such stars should no longer be included in lists for telescopic observation with the micrometer. W. W. B.

1261. *Magnitudes in Star Clusters.* XI. *Frequency Curves of Absolute Magnitude and Colour Index for* 1152 *Giant Stars.* **H. Shapley.** (Nat. Acad. Sci., Proc. 6. pp. 293–300, June, 1920.)—The stars considered are those in the clusters M. 3, 5, 11, 13, 15, 30, and 68; and N.G.C. 4147 and 7006, and the intervals are 0·2 mag. in colour index and 0·5 mag. in absolute photo-visual magnitude. Stars fainter than zero absolute magnitude are omitted, but are only 7 in number. The distances range between 7000 and 70,000 parsecs. The luminosity curves are only given for 946 stars in the three clusters M. 3, 11, and 13. Hardly any star appears to have an absolute magnitude brighter than — 6 and fewer than one in a thousand are brighter than — 4-magnitude (photo-visual). Only 3 of the 1152 stars are slightly abnormal in colour, which confirms the alleged uniformity of stars throughout the universe. W. W. B.

LIGHT.

1262. *Ray-Plotter.* **F. G. Smith.** (Optical Soc., Trans. 21. pp. 100–101; Disc., 101, 1919–1920.)—Describes a simple mechanical device for using the principle of Young's construction of the refracted ray, without the necessity for drawing the circles of that construction. The device consists of a T-square, made in celluloid or other transparent material (see Fig.) on which are marked points B,C A,O in a straight line as shown, AO being taken of any convenient length, and AB, AC being made equal to *n* AO and 1/*n* AO respectively. Placing the instrument so that O is over the point of incidence, and the line OA over the normal, and using a needle put through the pivot-hole at A as centre, the point B is set on the incident ray. Then C is a point on the line of the refracted ray. The points B,C are also pierced through for marking and setting off.



J. W. T. W.

1263. *Relation between the Refractivity and Density of Carbon Dioxide.* **P. Phillips.** (Roy. Soc., Proc. 97. pp. 225–240, May 1, 1920.)—The relation given by Lorenz and Lorentz, $(\mu^2-1)/(\mu^2+2)\rho=\text{const.}$, between the refractivity and density of various gases has been generally regarded as true within the limits of their experimental errors. This, however, is not accurate when applied to the large changes of density from a gas to a liquid. It is evident that the densities used in the experiments with gases have not been great enough to exhibit the variations of the Lorenz and Lorentz constant. By experimenting with a gas just above its critical temperature large continuous changes of density may be produced, and for this reason this experiment was carried out with carbon dioxide at a temperature of 34° C. Nearer to the critical temperature than this, the CO_2 is so sensitive to the smallest change in temperature or pressure that it was found too difficult to manipulate. Continuous changes of density from 0·73 gm./cm.^{3} downwards were quite readily obtained, and by means of a Fabry and Perot étalon the continuous change in refractivity was observed. The general arrangement of apparatus is very fully described, and accompanied by three diagrams. Then follows a detailed account of the method of experiment, together with the calculation of results. The expansion of the vessel due to internal pressure was tested, but found to be inappreciable in its effect on the density. A test of purity of the CO_2 employed showed never more than 0·1% of air to be present. Tables of results with explanatory curves are given. It is seen that $(\mu^2+2)\rho/(\mu^2-1)$ increases with ρ, but is not a linear function. A long discussion of the results is given. The inverse of the Lorenz and Lorentz constant is shown to be a linear function of ρ^2, and the author considers at some length the interpretation to be given to this result. Lorentz and Lorenz, in arriving at their constant, considered the effect produced on an electron of given free frequency by the alternating field in the light and by the field due to the polarisation of the surrounding molecules. The latter field was calculated by assuming the electron to be at the centre of a spherical cavity, the polarisation on the walls of which produced the field at the centre. This field, due to the polarisation, was calculated to be $4\pi P/3$, where P is the electric polarisation. Lorenz and Lorentz have suggested that the field may not be exactly $4\pi P/3$, but may be $(4\pi/3 + \sigma)P$, where σ is a small constant. This would lead to $(\mu^2 + 2)\rho/(\mu^2 - 1)$ being a linear function of ρ, which is not the case. Natanson states that σ will depend upon the density of the medium. If it be assumed directly proportional to the density the author derives an equation which is of the form obtained from his experiments.

The paper concludes with a comparison of previous results.

H. H. Ho.

1264. *Diffraction Patterns in the Presence of Spherical Aberration.* [**Mrs.**] **C. H. Griffiths.** (Optical Soc., Trans. 21. pp. 87–96; Disc., 97–99, 1919–1920.)—A test for spherical aberration is the appearance of the expanded image in the neighbourhood of the focus. Immediately inside and outside the focus are diffraction ring patterns, the number of rings increasing with the distance from the focus. The symmetry of these ring patterns is a valuable guide to the quality of the objective. With an objective free from aberration the inside and outside focus appearances are almost the same. With an over-corrected objective the ring system outside the focus will be clearer and better defined than that inside the focus. With an under-corrected objective the reverse will be the case. The greater the aberration the greater the lack of symmetry. In the present paper photographs and records are given of the appearance of the images and of the expanded images on each side of the focus of a telescope objective, when there were known differences of optical path between the marginal and paraxial rays of 0 to 2 wave-lengths.

J. W. T. W.

1265. *Experimental and Theoretical Investigations into the Aureola Phenomena in Homogeneous Fog.* **R. Mecke.** (Ann. d. Physik, 62. 7. pp. 623–648, Aug. 4, 1920.)—This paper contains Part II of the investigation, and deals with the theoretical considerations underlying the experimental Part I previously published [see Abs. 820 (1920)]. The discussion is based on the diffraction theory of small spherical lenses. Section 1 considers diffraction phenomena at opaque spheres, while diffraction and interference at transparent spheres occupy Section 2. The calculation of phase displacement and amplitude is contained in Section 3. The influence of the light reflected at the surface of drops upon the diffraction phenomenon is investigated in Section 4. The paper concludes in Section 5 with an application of the diffraction formula for small spherical lenses to the diffraction phenomena in a homogeneous fog. In place of the simple diffraction formula for opaque circular discs, however, a very complex equation arises due to the interference of the diffracted light with that reflected at the surface of the drops. As a consequence, the drop size can no longer be calculated from the ring

V.2
192

diameters. Only the colour of the central field for small drops, which resembles the colours of thin films, permits the determination of drop size with any accuracy, owing to regularity in colour sequence. With larger drops, as in Mierdel's researches and exclusively in the case of natural fog, the old diffraction formula for the calculation of drop radii from ring diameters is applicable, since the influence of transparency and surface reflexion are no longer observed, the drops behaving entirely as opaque circular discs. H. H. Ho.

1266. *Lippich's Projective Theorem in Geometrical Optics.* **A[lice] Everett.** (Phil. Mag. 40. pp. 113–128, June, 1920.) — A proof is given of Lippich's theorem that if the corresponding incident and refracted portions of a ray, which is infinitely near to a chief ray lying in a principal section of a refracting surface, be projected upon either the tangential or sagittal sections of the chief ray, then the projections also correspond. In this connection, the tangential section is defined as that principal section of the surface, at the point of incidence of the chief ray, which contains the chief ray and the normal; it coincides with the plane of incidence. The sagittal plane is defined as a plane through the chief ray perpendicular to the plane of incidence. The sagittal sections for the incident and refracted chief rays are in general different, and not principal sections. The proof given in the paper is geometrical, and it is shown that the theorem holds less accurately for the sagittal than the tangential projection. J. W. T. W.

1267. *Auramine as a Sensitiser.* **O. Bloch** and **F. F. Renwick.** (Phot. J. 60. pp. 145–146; Disc., 147, April, 1920.)—Auramine is a well-known yellow basic dye, chiefly used in colouring paper. It is the hydrochloride of a base having the formula: $\left\{(CH_3)_2 > N - (C_6H_4\right\}_2 = C = NH$, or a dimethyl-amido derivative of imino-diphenylmethane. Its use in photography has been practically restricted to the preparation of yellow filters, but even for this purpose it was abandoned on the introduction of the more stable Filter Yellow K and its successors; it has also been suggested for use in self-screened orthochromatic plates. It has been found previously that a little advantage was usually to be gained by the employment of small quantities of auramine in the dye-bath, but no use has been made of this.

Auramine has now been examined afresh, both alone and in conjunction with other sensitisers. Used alone, it has no useful sensitising action on silver gelatino-bromide plates. Critical examination of plates treated with it shows that there is only a slight displacement of the maximum of sensitiveness towards the blue-green of the spectrum unless sufficient is used to subdue the violet end by its screening action. With gelatino-chloride plates, however, it proved to be a powerful sensitiser for the light blue of the spectrum, a region in which such plates are normally insensitive. When an isocyanine such as Sensitol Green (pinaverdol) or Sensitol Red (pinacyanol) is used with a small addition of auramine, altogether insufficient in amount to depress the blue sensitiveness by its screening action, a marked enhancement takes place of the sensitising properties of isocyanine in regions of the spectrum for which the auramine itself does not sensitise in the slightest degree. Moreover, it appears to be a general property of such combinations, for auramine exerts a similar stimulating action on quite a number of new isocyanines. In addition to giving improved colour-sensitiveness, addition of auramine in very small quantity has the valuable merits of restraining the fogging tendencies of the isocyanines and of materially prolonging the useful life of the plates. No real loss of colour-sensitiveness with age has been found, though, as with all gelatine dry plates, the speed of development becomes slower as the film gradually hardens. The spectrograms given in the article illustrate the nature and magnitude of the effect of a small addition of auramine in a few typical cases. A. E. G.

1268. *Theory of Mirage.* **K. Aichi.** (Phys.-Math. Soc. Japan, Proc. 2. pp. 130–136, June, 1920.)—Develops the theory of the mirage from the basis of the observed phenomena, and deduces the various arrangements of layers of air of different refractive indices which can give rise to such appearances. The different cases of erect and inverted images and combinations of these can be readily explained on the mathematical theory described in the paper. J. W. T. W.

1269. *Dispersion in Optical Glasses.* **F. E. Wright.** (Optical Soc. of America, J. 4. pp. 148–159, May, 1920.)—Shows that for 316 types of silicate optical glass, if either of the partial dispersions $n_F - n_D$ or $n_{G'} - n_F$ are plotted as ordinates against $n_D - n_A$ as abscissæ, the results lie in each case on a straight line (within a unit in the fourth place of decimals). This means that, for all such glasses, once a partial dispersion is given the entire dispersion curve is fixed irrespective of the glass type. Hence if any partial dispersion is given, all other dispersions follow automatically, and a change in dispersion at one part of the dispersion curve carries with it definite changes in the curve throughout the visible spectrum. Thus a series of standard dispersion curves can be set up independent of the absolute refractive index. This means that if, for any substance, two refractive indices are given, the dispersion curve can be written down at once; further, that in case two substances of very different indices are found to have the same actual dispersion for one part of the spectrum, their dispersion curves are identical, to one or two units in the fourth decimal place, throughout the visible spectrum. From these relations it is possible to build up dispersion formulæ containing two, three, or more constants which represent the data in the visible spectrum with a high degree of accuracy. Certain of these formulæ are of such form that they are valid far into the infra-red and ultra-violet, but break down of necessity as an absorption band is approached. Certain of the dispersion formulæ thus obtained are well adapted for computation purposes. J. W. T. W.

1270. *Surface Layer of Optical Polishing Tool.* **J. W. French.** (Optical Soc., Trans. 21. pp. 82–86, 1919–1920.)—The author considers that in the later operating stage of a polishing tool, the surface layer consists of a continuous layer of glass of a thickness not exceeding two or three wave-lengths. He concludes, therefore, that in the final stage the polishing is principally due to the action of a very thin uniform layer of water between two uniform flat glass surfaces.

In the *discussion*, **H. D. Taylor** considered that the polishing was due to the abrasive action of the rouge and that, although a certain amount of glass detritus might take part in this abrasive action, the surface of the polisher consisted of a pitch surface embedded with rouge, and that a glazed surface was unfavourable for polishing. Taylor, Taylor and Hobson's Research Department pointed out that a drop of benzine placed on a used polisher dissolved the pitch surface which could not, therefore, be regarded as covered with a continuous layer of glass. In reply, the **Author** said that this was due to the excessive thinness of the glass layer and irregularities in the pitch surface which caused it to be uncovered in spots, and to contaminate the glass layer. He considered that the polishing action was due to surface flow of glass, and not mainly to abrasive action. J. W. T. W.

1271. *Nodal Points for Lens Testing.* **G. W. Moffitt.** (Optical Soc. of America, J. 4. pp. 1–8, Jan., 1920.)—In using the nodal point method of lens testing, the true value of f is $\left\{aa'/(a+a')\right\}\left\{1-s'/(a-a')\right\}$, where a and a' are the respective distances of the object and image from the axis of rotation of the lens, and s' is the distance through which the lens has to be moved in passing from one nodal point to the other. The second term in the right-hand bracket cannot always be neglected. The formulæ for the determination of field characteristics are also given in the paper. J. W. T. W.

1272. *Search for Fizeau-Effect in Electron Stream.* **R. Whiddington.** (Nature, 105. pp. 708–709, Aug. 5, 1920.)—The author records the null result of an attempt to detect the Fizeau-effect in a beam of light passing along a rapidly moving stream of electrons. A pair of Jamin plates giving a separation of the interfering beams of 33 mm. was set up so as to produce achromatic fringes from the light of a mercury-vapour lamp. Two exhausted tubes, one containing a glowing kathode and cylindrical anode connected to an alternating source of potential of 100,000 and alternatively 5000 volts, corresponding to electron speeds of about 2×10^{10} cm./sec. and 4×10^{9} cm./sec. were placed, parallel, one in each of interfering beams. Wide fringes were first obtained, and then the filament-heating current and the alternating potential were turned on in succession. No shift or certain broadening of the fringes was observed. G. W. DE T.

1273. *Recognition of Detail.* **S. D. Chalmers.** (Optical Soc., Trans. 20. pp. 297–310; Disc., 310–314, June, 1919.)—Considers at length the various factors entering into this problem, namely: (1) the amount of light received from each element of the detail to be observed, (2) the contrast between the neighbouring parts either in brightness or colour, (3) the quality of the optical images, (4) the limits imposed by the diffraction of light and the aperture of the eye, and by the coarseness of the receiving elements of the retina. Under (1) it appears that for the recognition of true intrinsic brightness of the object, the quantity of light necessary for recognition as light must be concentrated on the area of a single cone; for the recognition of colour the effect of increased area is that the illumination multiplied by the linear dimensions is constant; while the illumination so calculated for the area of a single cone is that necessary for the recognition as the intrinsic brightness. When necessary for the recognition as light the total quantity of light may be added up for areas not greater than about 50′ square, and the quantity so received is about $0{\cdot}02 \times 10^{-6}$ candle at 1 m. When the area exceeds

50′ square the total quantity of light necessary for recognition varies as the linear dimensions of the object up to about 3°. As regards the relation between visual acuity and brightness, it appears that since a certain amount of light is necessary to produce the sensation of light, detail cannot be recognised unless each element of the detail sends to the eye sufficient light for its recognition. Under (2), for distinctness of contrast it is necessary that the difference in the illumination be at least 0·5% of the actual illumination; but if this illumination falls below a certain value the fraction increases. This is due to the necessity for a certain minimum quantity of light to produce any effect. The effect of any additional illumination will be cumulative over a considerable area, but only as the linear dimensions, above the area for which the normal illumination is effective. A final section of the paper deals with the accuracy of setting in an optical instrument.

In the *discussion*, **J. Guild** said that he thought Fechner's law was a physiological one and that it was the departure from this law at low illuminations that required explanation. As regards setting in optical instruments he considered that the most important factor in every type of setting suitable for accurate work was the observer's sense of form symmetry. The illumination had to be sufficient to avoid strain in seeing the object and cross-lines distinctly, while it should not be high enough to spoil the acuity of the eye by glare and irradiation effects.

J. W. T. W.

1274. *Photographic Absorption of Lenses.* **G. W. Moffitt.** (Optical Soc. of America, J. 4. pp. 83–90, May, 1920. Paper read before the Am. Phys. Soc., Dec., 1919.)—Describes a method for determining the absorption of light by a photographic lens, using for this purpose the relative exposures necessary to produce equal densities on a photographic plate when used with and without the lens. The source used is an opal glass window in a cubical box containing a tungsten lamp, and the light is brought to approximately the same spectral distribution as daylight by means of a colour-filter. A plate is exposed, in a series of strips for a succession of different periods, to the image of this window produced by the lens system under investigation. It is then exposed for a number of different periods, to the direct light from the window. From the developed plate the relative times required for equal densities in the two cases may be found, and the ratio thus determined gives the transmission of the lens system for light of photographic quality, using a formula derived theoretically in the paper. This formula is only applicable to axial transmissions and it is therefore desirable to express oblique transmission values in terms of the axial transmission coefficient.

J. W. T. W.

1275. *The Photometric Constant.* **G. I. Higson.** (Phot. J. 60. pp. 161–163, April, 1920.)—Hurter and Driffield postulated that in a photographic negative the amount of silver per unit area was strictly proportional to the density D, which is related to the transparency T as follows: $D = \log 1/T$. They found that the weight in gm. of silver per 100 cm.^{2} = PD, where P is a constant which is known as the photometric constant and is the number of gm. of silver required to produce a uniform unit density in a photographic negative 100 cm.^{2} in area. They verified this proportionality for densities from 0·5 to 2 and obtained for P the value 0·0121. Eder confirmed this ratio for a similar range, obtaining a value 0·0103, and Sheppard and Mees carried the confirmation up to the density of 3·5. No theoretical reason for the constancy of these figures appears to have been given, but Nutting investigated the absorption of light by silver grains by the methods of the theory of probability, and concluded that the constant would be dependent on the size of the grains; this method, however, involves certain assumptions which are not justified in practical cases. The general theoretical basis has been discussed by Slade, and he confirmed the constancy, but made no allowance for the size of grain composing the deposit. By an elaboration of his method it is possible to obtain the complete relation between density, quantity of deposit, and size of grain, although the state of silver in a developed negative—each grain having a structure comparable with that of a sponge—hinders the extension of these relations to the weight. This relationship is worked out and it is shown that P depends on both the diameter of the grains and their effective specific gravity, and can only be accidentally constant for various silver deposits. The application to a photographic negative is considered and the conclusion is arrived at that the experimental results obtained are in excellent agreement with the theory. A. E. G.

1276. *Photometry of Visible Light Rays by means of Leuco Bases of certain Organic Dyestuffs Sensitive to Light; also with Silver Chloride and Chromate Paper respectively.* **J. M. Eder.** (Akad. Wiss. Wien, Ber. 128. 2a. pp. 507–538, 1919.)—White silver chloride paper finds general use in colour photometry, possessing max. sensitiveness between the violet and ultra-violet region of the spectrum. Although extremely sensitive towards ultra-violet, violet, and blue, it is practically inert towards green, yellow, and red light, and so is applicable for the photometry of the former. Silver chloride which has been suitably darkened by light (silver photo-chloride) possesses an appreciably higher reactivity for the greenish-yellow and orange, and has been utilised by Hecht for photometric purposes. Andresen in 1898 introduced novelty by the use of a silver bromide paper tinted with rhodamine B in a Scheiner sensitometer, and obtained an appreciable effect in the green region of the spectrum. The present author investigated the effect of the solar spectrum on such a rhodamine-silver bromide paper in 1902, and established, that in addition to the moderately improved sensitivity for yellowish-green, there still remained a considerable amount of reactivity towards blue and violet. No further progress, however, has been recorded along these lines, and the present author now describes an entirely new method for the photometry of the red to green region. Many leuco bases of organic dyestuffs have been investigated which oxidise readily in air to the original shade, but only under the influence of light. Gross, who investigated various derivatives of fluorescein, has observed that photo-oxidation of leuco compounds is not only due to absorbed light, but that the dyestuff thereby generated takes part in the reaction as well. Later, König found that the leuco bases of many classes of organic dyestuffs are rapidly oxidised by light when they are mixed with nitrocellulose (collodion), nitro-glycerine, mannite, or glucose, and then dried. In this way red, yellow, green, blue, and violet paper photographs were prepared, according to the choice of leuco base, which could be fixed by means of monochloracetic acid [Zeits. f. angew. Chem., 17. p. 1633, 1904]. Meister, Lucius and Brüning have patented papers for colour photography stained with leuco rhodamine, leuco flavaniline, and leuco setocyanine, to which various substances have been added for accelerating or retarding the optical effect; *e.g.*, nitro bodies and bases of the quinoline series accelerate, also glycerine, while urea, antipyrine, and citric acid retard. The fixing agent is an aqueous alcoholic solution of monochloracetic acid. These processes have not hitherto been investigated spectroscopically and photometrically, and the present paper records work carried out in this field. The preparation of the leuco base papers is described in detail, and then the experimental arrangements. The compositions are given of the violet, green, and red light-filters used; a diagram being added to show the transmitted lights through filters of blue ammoniacal copper and yellow potassium chromate solutions respectively. A comparison is shown between the sensitivities of leuco base papers and those of silver chloride, the bases used being prepared from brilliant green, malachite green, crystal violet, rhodamine B, 3B, and 6G, leucaniline, and leuco blue. These latter are sensitive for the complementary colour corresponding to the absorption maximum, and are much superior to silver bromide and chloride papers which have been sensitised with dyestuffs. In addition to red, yellow, and green light, the leuco bases are sensitive for blue-violet and ultra-violet as far as $\lambda = 3000$. Rhodamine 6G is most suitable for green and yellow green, leuco-brilliant green for red and orange. Since the sensitivity of the leuco base papers and the intensity of their colour depends on the concentration of the base solutions, thickness of collodion layer, and temperature, while foreign matter also exerts an influence, the papers were standardised before use in magnesium light against the Bunsen normal silver chloride paper. For blue light chromate paper is to be preferred, while silver chloride is best for the extreme violet and ultra-violet. A recent improved preparation for blue light contains potassium monochromate and ammonium oxalate. The light reaction in the case of the leuco base paper is a photo-oxidation, while for chromate and silver chloride papers it is a reduction effect. H. H. Ho.

1277. *Luminous Efficiency of Incandescent Bodies.* **R. Painvin.** (Rev. Gén. d'Él. 7. pp. 787–791, June 12, 1920.)—Develops a formula for the luminous efficiency (ratio of luminous to total radiation) of a black body in terms of its temperature, using Planck's equation. No account is taken of the varying sensitivity of the eye at different wavelengths. The same method is applied to find the luminous efficiency of tungsten and platinum, and that of tungsten at a number of different temperatures. The efficiency thus determined for a tungsten lamp operating at 1·2 watts per candle (neglecting all losses by processes other than radiation) is 4·7%. It is pointed out that although a body may radiate selectively in the visible spectrum, it cannot radiate more than the black body *at the same temperature.* J. W. T. W.

1278. *The Total Radiation of the Hefner Lamp.* **W. Gerlach.** (Phys. Zeits. 21. pp. 299–300, June 1, 1920.)—The author has previously measured in absolute units the total radiation of the Hefner lamp by means of the thermopile method [Abs. 1813 (1913)]. The present experiments were undertaken to ascertain the influence of moisture and CO_2 on the total radiation. It is concluded, as the result of the observations made, that neither the total radiation nor the measuring of the total radiation of the Hefner lamp is influenced by changing the water-vapour and CO_2 content of the air. A. E. G.

1279. *Ionisation and Resonance Potentials of Helium.* **J. Franck** and **P. Knipping.** (Zeits. f. Physik, 1. 4. pp. 320–332, 1920.)—In a previous paper [Abs. 251 (1920)] values of 20·5 volts and 25·4 volts were given for the resonance and ionisation potentials of helium. These results are in good agreement with those of Horton and Miss Davies [Abs. 1090 (1920)]. Theoretical considerations based on the work of Sommerfeld and Rubinowitz lead to the conclusion that there should be two resonance potentials for helium, differing by 0·8 volt. In the normal single-quantum condition, as the work of Landé and others shows, helium has two electrons travelling in markedly different paths (crossed condition), while helium with coplanar electrons should only exist in a bi-quantum or multiple-quantum condition. The two resonance potentials, differing by 0·8 volt correspond to the two limits of the principal series. Experimental evidence is given in the present paper of the existence of these two potentials. One set of results gives the first at 20·4 to 20·5 volts, the second at 21·25 volts, and the ionisation potential at 25·3 volts. In other experiments marked kinks in the curves were obtained at 21·9 and 23·6 volts. These correspond to lines in the helium spectrum of wave-lengths 569 and 523 Å. respectively, and the values 21·25 volts and 25·3 volts correspond respectively with the lines 585 and 493 Å. These results agree with a simple series formula. A. W.

1280. *Krypton and Xenon.* **J. N. Collie.** (Roy. Soc., Proc. 97. pp. 349–354, July 1, 1920.)—Experiments made with tubes containing krypton and xenon revealed a number of lines at the red end of the spectrum. The lines produced both by the ordinary discharge and by the condensed discharge were measured, and a table of wave-lengths and intensities is given. It has previously been noted [Abs. 49 (1919)] that when vacuum tubes containing the rare gases in a state of perfect purity have a moderately strong discharge from a coil passed through them, even at pressures as high as 40 mm., cadmium could be easily volatilised from a cadmium kathode. But in one respect xenon differs from the other rare gases, for when a xenon tube becomes vacuous after heavy sparking, only a very small portion of the xenon can be set free again by strongly heating the splashed metal. This is not the case with the other rare gases, which can be easily recovered by heating the tubes. Various electrodes were tried and in every case xenon disappeared, and experiments up to the present have failed to demonstrate what has become of the gas. The probability is that the xenon has formed some compound with the electrodes, and this compound goes into solution on dissolving the electrodes. A. W.

1281. *Excitation of Band Spectrum of Nitrogen by Electrons with Small Velocities.* **L.** and **E. Bloch.** (Comptes Rendus, 170. pp. 1380–1382, June 7, 1920.)—For the experiments described a three-electrode valve was used, with the anode and grid permanently connected together. To this valve was sealed a glass tube concentric with the filament and provided with a fluorite window, and the radiations generated in the contained gas by a potential difference between the anode and filament were observed by means of a quartz prism spectrograph of small dispersion. Mercury lines (due to the pump used) were always present with a voltage of about 12, and when this was reduced to about 10 volts the mercury spectrum consisted of a single line $\lambda 2536$, as found under similar conditions by Franck and Hertz. In spite of the presence of mercury lines a number of bands of the second positive spectrum of nitrogen were identified. The bands were more intense when the pressure in the apparatus was allowed to rise to a few hundredths of a mm. The results show that the band spectrum of nitrogen can be excited under a critical potential of about 10 volts. A. W.

1282. *Structure of the Balmer Series of Hydrogen Lines.* **T. R. Merton.** (Roy. Soc., Proc. 97. pp. 307–320, June 1, 1920.)—Further experiments on the Balmer series lines have yielded interesting results, which are described in the present paper. In the case of H_α the two components observed are very sharply defined, and any additional components must be either of vanishingly small intensity or at an exceedingly small distance from the main components under the conditions of the experiment, for the value found for the half-width, $\delta\lambda = 0{\cdot}028$ Å., is very close to the theoretical value 0·023 Å. On the other hand, the half-width of the components of H_β, $\delta\lambda = 0{\cdot}045$ Å., though of doubtful accuracy, is much in excess of the theoretical value 0·017 Å., a result which might well be accounted for by the disturbing influence of one or more weak additional components. If the series, under the conditions of experiment, consisted of doublets of constant wave-number difference, a difference in wave-length of 0·145 Å. (the observed separation) between the components of H_α would lead to a corresponding difference between the components of H^β of about 0·08 Å. The experimental value for H_β, 0·093 Å., would not appear to negative this arrangement. Although it is impossible to attach great weight to the exact numerical values for H_β, it is evident that the separation is of a magnitude appropriate to a diffuse or sharp series. It is believed that considerable weight may be attached to the value given for the separation of the components of H_α, for they were completely resolved and well defined.

These results, which were obtained with tubes containing a mixture of hydrogen and helium, are not in accordance with observations made with tubes containing pure hydrogen, or hydrogen with a small amount of impurity. The separation of the components of H_α appears to become smaller as the gas is purified, and the minimum between the components becomes brighter, to an extent which seems quite out of proportion. The appearance of both H_α and H_β in hydrogen of the highest degree of purity does not suggest unresolved doublets with broad components of the separations given above, but is rather in accordance with doublets of a somewhat smaller separation in the case of H_α, and a considerably smaller separation in the case of H_β, the components in neither case being resolved. Taking all these results into consideration it seems that the structure of the lines must be complex, for it does not appear possible to explain the observations on the basis of simple doublets. If, however, it may be assumed that the lines consist of three or more components which vary in their relative intensities under different conditions, the observed changes can easily be explained. [See Abs. 1132 (1917), 1831 (1914), and 1508 (1919).] A. W.

V.2
192

1283. *Secondary Spectrum of Hydrogen.* **M. N. Saha.** (Phil. Mag. 40. pp. 159–161, June, 1920.)—Considerable interest has recently been taken in the secondary spectrum of hydrogen on account of its importance with regard to Bohr's theory of the quantum emission of spectral lines. [See Abs. 371 (1920).] Some physicists ascribe the secondary spectrum to the molecule of hydrogen, the primary spectrum being due to the atom. Others, on the basis of the experiments of Fabry and Buisson, consider that at least a part of the secondary spectrum may be due to the hydrogen atom. Investigation of the work of Fabry and Buisson shows that probably proper interpretation has not been put on their experimental results. These results show that if M_1, M_2 are respectively the masses of the radiating centres for H_α and for a certain secondary line, then $M_2 = 2M_1$ very approximately. Hence, if the H_α line is emitted by the hydrogen atom, the secondary lines are emitted by the hydrogen molecule. Further experimental work on the subject is needed. Theoretically, the difficulty is both mathematical and physical, as up to the present we have no mechanical model which enables us to visualise in a satisfactory manner the coupling of two Bohr atoms into a hydrogen molecule. A. W.

1284. *Ionisation and Resonance Potentials for Electrons in Vapours of Lead and Calcium.* VI. **F. L. Mohler, P. D. Foote,** and **H. F. Stimson.** (Phil. Mag. 40. pp. 73–79, July, 1920. Abstract from Bureau of Standards, Bull.)—Previous papers [Abs. 941 (1918), 297 and 434 (1919)] have discussed measurements made of the ionisation and resonance potentials of a number of metals. Satisfactory results have now been obtained for lead and calcium. The resonance and ionisation potentials of lead are 1·26 and 7·93 volts respectively. The spectrum line λ10291 gives the probable theoretical value for the former as 1·198 volts. Calcium was found to have two resonance potentials, one at 1·90 volts and the other at 2·85 volts, the first of these being the more prominent. Ionisation was observed at 6·01 volts. The following spectral frequencies determine these potentials:

First resonance ...... 1·5S − $2p_2$, λ = 6572·78 Å., V = 1·877 volts.
Second resonance...... 1·5S − 2P., λ = 4226·73 Å., V = 2·918 volts.
Ionisation .... 1·5S, λ = 2027·56 Å., V = 6·081 volts.

A. W.

1285. *Effect of Solvent on the Ultra-violet Absorption Spectrum of a Pure Substance.* **F. O. Rice.** (Am. Chem. Soc., J. 42. pp. 727–735, April, 1920.)—The effect of dissolution in a solvent on the absorption of acetone and its homologues [see Abs. 305 (1915)] is investigated. The results obtained show that all the aliphatic ketones except acetone and methyl ethyl ketone follow Beer's law, the molecular extinction being independent of the concentration and of the solvent. With acetone and methyl ethyl ketone there are deviations when ionising solvents are used, owing to partial disruption of the associated molecules. Kundt's rule, according to which the absorption band is displaced towards the red as the solvent increases in refractivity, holds good as a rough generalisation. When a pure substance is dissolved in a solvent of ionising type, the absorption centre moves towards the ultra-violet, whereas if the substance is dissolved in a solvent of neutral, non-ionising character the absorption centre either remains unaffected or undergoes displacement towards the red end of the spectrum. It is probable that this is a general rule valid for absorbing substances of all classes. T. H. P.

1286. *Spectra of Isotopes.* **W. D. Harkins** and **L. Aronberg.** (Am. Chem. Soc., J. 42. pp. 1328–1335, July, 1920.)—Details of the experimental work on the spectra of ordinary lead and a lead from radium of atomic weight 206·312 were presented in two previous papers [Abs. 271 and 678 (1918)]. It was found that the wave-length of the line $\lambda 4058$ as obtained from the radio-lead was 0·0044 Å. greater than that from ordinary lead, this effect being 100 times greater than that predicted by the theory of Bohr, and enormously greater than that predicted by the simple gravitational theory. Merton [Abs. 105 and 374 (1920)] has recently confirmed this result, his measurements showing that both the direction and magnitude of the shift are the same, within the limits of error, as the above. Taking all things into account the agreement is as good as could be expected, the electron in the heavier atom always showing the greater frequency, as would be predicted from theory if it is the additional mass in the nucleus which produces the effect. If this is the case an effect upon the vibration of an electron has been discovered, the only apparent cause of which is the change in the mass of the nucleus of an atom, which must then be accompanied by a change in the force acting upon the electron, or the vibration period of the latter would not be changed. The interest in this phenomenon lies in its close relationship to gravitation, and also in the fact that its magnitude far exceeds ordinary gravitation, which would seem to indicate that such small-scale mass effects do not follow the same simple law as large-scale gravitational effects. The authors' results, together with those of Merton, indicate that isotopes which differ in atomic weight may be distinguished by their spectra. The wave-length of the spectrum lines is the first property, apart from mass and atomic stability, in which isotopes have been found to differ, and it is the first property showing such a difference which is due to an effect on the planetary electrons. Isotopes may possibly differ in other respects, but the magnitude of such differences may be too small to be measured. A. W.

1287. *Light Absorption and Fluorescence.* VI and VII. **E. C. C. Baly.** (Phil. Mag. 40. pp. 1–14 and 15–31, July, 1920.)—The first of these papers, on "atomic and molecular energy quanta," considers the quantitative relationships between the various frequencies exhibited by a substance in the light of the energy-quantum theory. These relationships have been detailed in various papers [Abs. 1405 (1915), 891 (1916), and 1175 (1920)], and seem to offer a very definite opportunity for the application of this theory. The relationships which exist may be briefly stated as follows: (1) Every elementary atom possesses one or more frequencies which are characteristic of the element. (2) When atoms of different elements enter into combination the resulting molecule is endowed with a new frequency which is the least common multiple of the frequencies of the atoms it contains. This may be called the true molecular frequency. (3) The central features of all absorption bands—that is, those frequencies for which the absorptive power is greatest—are molecular frequencies characteristic of the molecules, since these alone persist when the substance is cooled to low temperatures.

(4) The molecular frequencies in the visible and ultra-violet regions are exact multiples of a molecular frequency in the short-wave infra-red, which may be called the infra-red fundamental frequency. (5) The infra-red fundamental frequency is an exact multiple of the true molecular frequency. (6) The breadth of an absorption band as observed at ordinary temperatures is due to the combination of the molecular central frequency with subsidiary frequencies. (7) Each observed absorption band consists of a series of sub-groups symmetrically arranged round a central sub-group. If M be the central molecular frequency, the frequencies of the central lines of the sub-groups will be given by $M \pm nI$, where $n = 0, 1, 2, 3$, etc., and I is the least common multiple of the frequencies of a group of atoms within the molecule. This may be called an intra-molecular frequency. (8) Each sub-group consists of a central line with series of lines symmetrically arranged round it. If F be the frequency of the central line, then the series of lines will have frequencies given by $F \pm nA_1$, $F \pm nA_2$, etc., where again $n = 0, 1, 2, 3$, etc., and A_1, A_2, etc., are those atomic frequencies whose least common multiple is equal to I. It seems probable that the atomic frequencies are connected with the shift of an electron from one stationary orbit to another, and on this assumption an explanation of the molecular frequencies can be derived, and a satisfactory account given of various chemical properties of molecules as well as of the structure of the absorption bands. It is shown, on the assumption that every elementary atom is characterised by one or more elementary quanta of energy, that the resulting molecule when freshly synthesised is characterised by a molecular quantum of energy, and hence by a fundamental frequency in the infra-red. The affinity of the atoms for one another is discussed in the second paper, this phenomenon being the fundamental principle of chemical reaction and reactivity. The discussion is based on the work of Humphreys on the electromagnetic force fields of atoms [Abs. 1054 (1906)]. A. W.

1288. *Refraction of X-rays.* **P. Knipping.** (Zeits. f. Physik, 1. 1. pp. 40-41, 1920.)—Stenström (Dissertation, Lund, 1919) has described experiments on the reflection of X-rays, at glancing angles, from a crystal of NaCl. Certain peculiarities indicating a difference in the reflection characteristics, according to wave-length were noted; and a suggestion was made that the phenomena observed were due to differences in the refractive index of the NaCl crystal to waves of different wave-length.

The author now gives an alternative explanation without involving assumptions relating to refraction. Stenström's observations are accounted for solely by consideration of the peculiarities of the structure of NaCl crystals. A. B. W.

1289. *Theory of X-ray Spectra.* **A. Smekal.** (Akad. Wiss. Wien, Ber. 128. 2a. pp. 639–676, 1919.)—This paper deals mainly with the question of the arrangement of electrons in the atom. The treatment is mathematical and does not permit of a short abstract. A. B. W.

1290. *X-ray Spectra of the Elements.* **R. Whiddington.** (Phil. Mag. 39. pp. 694–696, June, 1920.)—The speed of the electron (v) carrying the same energy as the α-lines in the K- and L-spectra of the elements is shown to be fairly well expressed by the formula $v = C(N + D)$, where N is the atomic number of the element, and C and D are constants deter mined by the series. For the K-series $v = 2(N - 2)10^8$ cm./sec., and for the L-series $v = (N - 15)10^8$ cm./sec. A. B. W.

1291. *Fine Structure of X-ray Spectra.* **A. Sommerfeld.** (Zeits. f. Physik, 1. 1. pp. 135–146, 1920.)—A theoretical paper divided into the following sections:—(1) Frequency-differences in the M-series; (2) Application of the Selection principle to the fine-structure of the M- and L-series; (3) The different N-levels and their appearance in the L-series; (4) On Kossel's explanation of the combination defects; (5) On the quanta-numbers related to the simple atom-rings. A. B. W.

1292. *Structure of X-ray Spectra.* **W. Kossel.** (Zeits. f. Physik, 1. 1. pp. 119–134, 1920.)—A theoretical discussion of the structure of absorption and emission X-ray spectra of the elements. A. B. W.

1293. *Effect of Magnetic Field on Absorption of X- and γ-rays.* **T. Takeuchi.** (Phys. Math. Soc. Japan, Proc. 2. pp. 126–130, June, 1920.)—A mathematical paper not permitting of a short abstract. A. B. W.

RADIO-ACTIVITY.

1294. *Experimental Method of Drawing directly the Decay Curve of a Radio-active Composition.* **A. Piccard.** (Archives des Sciences, 2. pp. 262–263, May–June, 1920. Paper read before the Soc. Suisse de Physique.)—The author describes a simple method for determining the decay curve of a radio-active substance of short life, when it is difficult to determine the period by ordinary means. The fibre of an Elster and Geitel electrometer is projected on a screen, its position being marked as it descends under the action of the radio-active material. A second fibre is projected on the same screen, in this case the rate of movement being uniform, whereas before the rate of movement diminished with time as the radio-active product decayed. The position of the point of intersection of the two traces can be marked and the exponential curve deduced at once from the known rate of the fibre moving at constant speed. A. B. W.

1295. *Radio-activity and Gravitation.* **A. H. Compton.** (Phil. Mag. 39. pp. 659–662, June, 1920.)—The small degree of radio-activity of the earth's interior requisite to account for the age and present temperature of the earth, in view of the consideration that the high density of radio-active minerals makes it seem probable that they should occur more abundantly in the interior than in the surface crust, might be explained by a decrease in the energy of radio-active disintegration as the depth below the surface increases. Donnan [Abs. 402 (1920)] has shown by thermodynamic reasoning a relation between this energy and the gravitational potential which would cause a decrease, but wholly inadequate to account for the small development of heat in the earth's interior, as the author shows by calculation. He has sought for experimental evidence of a possible relation between the gravitational intensity and the rate of radio-active disintegration. Assuming Einstein's principle of equivalence between a gravitation field and a field of acceleration, a tube of radium emanation was placed in a hole near the circumference of a brass disc of 10 cm. radius, and the γ-radiations measured from slow rotation up to speed of 250 r.p.m. An average decrease of 0·06 ± 0·04 % only was observed, indicating the probability that an acceleration of 20,000 times gravity produces no effect on the intensity of γ-radiation as large as one part in 1000, so that the cause of the confinement of the earth's radio-activity to its surface crust must be sought elsewhere. G. W. DE T.

1296. *On the β-Recoil.* **A. Muszkat.** (Phil. Mag. 39. pp. 690–694, June, 1920.)—The author shows experimentally that there is an upper limit, 0·5, to the recoil efficiency whatever the nature of the surfaces employed. It was shown that the recoil efficiency diminishes with time, this effect being due to the penetration of the radio-active matter into the metal surface on which it is deposited. A. B. W.

1297. *Thorium and Uranium Content of Minerals. Induced Activity (active deposit ThA-B-C) for different Times of Exposure in Constant Thorium Emanation.* **S. Meyer.** (Akad. Wiss. Wien, Ber. 128. 2a. pp. 897–908, 1919.)—The Th/Ur ratio has been carefully determined for monazite sand and crystalline pitchblende.

In an appendix to the paper a table is given showing the amount of thorium active deposit obtained for different times of exposure to a constant source of thorium emanation. A. B. W.

1298. *The Constancy of the Ratio Ac/Ur in Natural Minerals.* **S. Meyer** and **V. F. Hess.** (Akad. Wiss. Wien, Ber. 128. 2a. pp. 909–924, 1919.)—The relative content of uranium and actinium in a number of minerals has been determined. The following were among the minerals examined: Amorphous pitchblende from Joachimstal in Bohemia, crystalline pitchblende from Morogoro in East Africa, broggerite from Norway, and two thorianites from Ceylon. The results indicate that the Ac/Ur ratio is remarkably constant in the same mineral in spite of the wide differences in geographical origin, condition (amorphous or crystalline), geological age, and variation in thorium content (Th/Ur between 6×10^{-5} and 6). A. B. W.

1299. *Relative Activity of Radium and Uranium with which it is in Radio-active Equilibrium.* **J. H. L. Johnstone** and **B. B. Boltwood.** (Phil. Mag. 40. pp. 50–67, July, 1920. Am. J. Sci. 50. pp. 1–19, July, 1920.)—The relation of the activity of radium to the activity of the uranium with which it is in radio-active equilibrium has been re-determined. The results obtained indicate that if the activity of uranium is taken as unity the activity of the radium is equal to approximately 0·49.

The total activity of uranium mixed with equilibrium quantities of its disintegration products has been compared with the activity of the uranium alone, and the former has been found to be 4·73 times the latter.

A critical examination has been made of the various theories which have been proposed to explain the genesis of radium and actinium from uranium. None of these theories appears to satisfy the necessary requirements. A. B. W.

1300. *The Attainment of Saturation Currents for α-rays in Plate Condensers.* **H[ilda] Fonovits.** (Akad. Wiss. Wien, Ber. 128. 2a. pp. 761–793, 1919.)—It is well known that saturation is much more difficult to attain for α-rays than for more penetrating radiations. The explanation of this lies in the marked difference in the ionisation effects, the "columnar" ionisation produced by α-rays being much more dense than the relatively feeble ionisation produced by β- or γ-rays. The author now describes a detailed investigation of the factors necessary to obtain α-ray saturation. Saturation curves for polonium in a plate condenser are given under a wide variety of conditions. Thus the intensity of the polonium source is varied to give a range of currents 1 to 2400 e.s. units, and the distance apart of the plates varied from 4 to 9 cm. A. B. W.

1301. *The Branching Ratios of RaC, AcC, ThC; and the Decay Constants of the C″ Products.* **E. Albrecht.** (Akad. Wiss. Wien, Ber. 128. 2a. pp. 925–944, 1919.)—The "half-value" periods of the C″ products (isotopic with thallium) of the three radio-active series have been measured, with the following results:

AcC″ .... $T = 4 \cdot 76$ minutes, $\lambda = 2 \cdot 43 \times 10^{-3}$ sec.$^{-1}$
ThC″ .... $T = 3 \cdot 20$ minutes, $\lambda = 3 \cdot 61 \times 10^{-3}$ sec.$^{-1}$
RaC″ .... $T = 1 \cdot 32$ minutes, $\lambda = 8 \cdot 7 \times 10^{-3}$ sec.$^{-1}$

Assuming the branching ratio obtained by Marsden, Darwin, and Barratt for ThC, namely ThC″/ThC = 0·35, to be correct, the ratios for actinium and radium are found to be as follows:

Actinium.............................C″/C = 99·84
Radium ....C″/C = 0·0004

Observations with RaC″ have demonstrated the phenomenon of aggregate-recoil referred to by R. W. Lawson [see next Abs.]. A. B. W.

1302. *Aggregate Recoil Accompanying the Decay of Substances Emitting α-rays.* **R. W. Lawson.** (Akad. Wiss. Wien, Ber. 128. 2a. pp. 795–830, 1920.)—If polonium is deposited by electrolysis on a clean metal foil it is found subsequently that, at normal pressures and *in vacuo*, surrounding objects become active also. The phenomenon can be explained on the supposition that aggregates of polonium atoms are carried off from the active surface and deposited on neighbouring surfaces. When an α-particle is ejected from such an aggregate in the direction of the active plate an equal and opposite momentum to that of the α-particle is imparted to the aggregate which may consequently leave the active surface and become deposited elsewhere. This phenomenon is termed "aggregate recoil." As a result of this type of recoil it is almost impossible to obtain a pure deposit of any decay product by a process of α-ray recoil.

It is found that the quantity recoiling from polonium in this manner, in "aggregates," is from 10 to 20 times as great as the quantity recoiling at normal pressure. For relatively short exposures the total aggregate recoil from polonium is proportional to the time. For longer exposures the relation is not so simple and irregularities are more frequently observed. The phenomenon has been carefully observed when the polonium was deposited on different metal surfaces, as, for example, on platinum, gold, and palladium. It was observed that the percentage loss, by "aggregate" recoil, per day in all cases diminished with time, the rate of loss being greater from the noble metals than from surfaces of the commoner metals. Thus from typical noble metals the rate of loss diminished to half its initial value in 7 to 12 days. For the more easily oxidisable metals this "half-value" time of the aggregate recoil was considerably greater, this difference being explained on the assumption that the aggregate are prevented from leaving the surface by a superficial oxide layer.

The rate of loss was much greater *in vacuo* than at normal pressures. Thus the period of polonium *in vacuo* appeared to be 59·6 days, instead of 136·5 days observed at normal pressures. This result indicates the importance of considering the effect of aggregate recoil when making a determination of the decay period of a radio-active substance. It is now shown that the apparent period is affected by many factors amongst which the following have been studied: (1) Surface on which the substance is deposited. (2) Length of time active substance has been on the surface. (3) Pressure of gas in which observations of decay are made. (4) Concentration of active deposit. A. B. W.

1303. *Hard Secondary Radiation from the γ-rays from Radium.* **K. W. F. Kohlrausch.** (Akad. Wiss. Wien, Ber. 128. 2a. pp. 853–895, 1919.)—The secondary radiations produced when radium γ-rays are incident on matter are very complex. The observations now described refer in particular to the two components S_1 and S_2. The hard S_1 rays produce the K_1-radiation, and the S_2 rays the K_2-radiation. The absorption and scattering coefficients for these characteristic radiations have been determined.

The theoretical bearing of the experimental results is discussed, particular reference being made to Debye's theory. A. B. W.

1304. *Measurements with RaF in a Guard-Ring Plate Condenser.* **G. Richter.** (Akad. Wiss. Wien, Ber. 128. 2a. pp. 539–569, 1919.)—Observations have been made by Mache and Flamm [see Abs. 75 (1913) and 247 (1914)] on the relation between distance apart of plates and saturation current, using a guard-ring plate condenser. In their experiments certain differences were noticed between the theoretical and observed values. The object of the present experiments was to determine, if possible, the cause of the discrepancies. Three formulæ for ionisation by α-particles were examined, namely: Geiger's, Flamm's, and Lawson's. The experimental results supported the formula given by Geiger: $f(\rho) = 1/(r - \rho)^{\frac{1}{3}}$, where $f(\rho)$ is the ionisation per cm. path of the α-particles at a distance ρ, and r the range of the α-particles. A. B. W.

1305. *Slow Variations in the β-radiation from Radium Preparations.* **F. Lerch.** (Akad. Wiss. Wien, Ber. 128. 2a. pp. 635–638, 1919.)—Discusses some apparent changes of β-activity observed when radium preparations are treated chemically. A. B. W.

HEAT.

1306. *Values of the Dilatations of Steels of the Nickel Type.* **C. E. Guillaume.** (Comptes Rendus, 170. pp. 1554–1557, June, 28, 1920.)—The variables, chiefly Mn and C, present in all "invar" renders the dilatation curve of iron-nickel alloys slightly uncertain. Using the correction factors for these elements obtained for considerable quantities [Abs. 1118 (1920)], observed values have been reduced to a standard of 0·4% Mn and 0·1% C. The minimum dilatation occurs with 35·6% Ni, the corresponding value of a_{20} being $1{\cdot}19 \times 10^{-6}$. The material had been hot rolled and air cooled. It is suggested that for the pure iron-nickel alloy the minimum dilatation would be no more than $0{\cdot}2 \times 10^{-6}$.

F. C. T.

1307. *Liquefaction of Air and a New Equation of State.* **K. Schreber.** (Phys. Zeits. 21. pp. 430–433, Aug. 15, 1920.)—The usual Thomson equation for the throttle-effect may be easily transformed into:

$$w = A(T(\partial v/\partial T)_p - v)/c_p, \text{ and } w = AT^2\left(\partial \frac{pv}{T}\Big/\partial T\right)_p\Big/c_p \cdot p.$$

This form shows that the points where $w = 0$ coincide with those at which $pv/T = P$ has its greatest value with respect to T. If $P = f(T)$, the lines agree very well with those found by different observers in the zone investigated. A very good representation of the complete course between − 140° and + 200° for different substances may then be obtained by means of the hypothesis of corresponding states. If the max. values be connected together, a transformation-point curve is obtained whose equation is $p^2 = a(T_u - T)$. In the $p - T$ field this is a parabola, whose axis coincides with the T-axis and whose vertex lies in T_u. A part of the field is thus enclosed between the curve and the axes, within which cooling, and external to which heating, takes place. The transformation curves obtained from the Van der Waals equation and its modifications, are quite impossible when the $p - t$ field is considered; *e.g.*, they are parabolas or parabola-like curves whose axis is parallel to the p-axis and so far displaced that both branches cut the T-axis in finite temperatures. If these transition points are exceeded by help of the Thomson equation in the $P - t$ field, every isobar should possess two maximum values in this field between which a minimum must fall, so that at this pressure three transition points exist, a circumstance which has never been observed. Such a wave-like course for $P = f(t)$ contradicts all probability. Jakob's curve based on Amagat's experiments is in like manner shown to be impossible. If the specific heat be regarded as unalterable, then from the transition curve it follows that $w = (A - Bp^2)/T - C$; *i.e.*, for curves of constant temperature, $-(w - a) = Bp^2/T$, where $a = A/T - C$. The curves of equal temperature are therefore parabolas whose axis coincides with the negative w axis, whose parameter is $\frac{1}{2}$T and whose vertex upon the w-axis changes with the temperature. For low temperatures, a is large and the parameter small, while with rising temperature the parameter increases and the parabola becomes wider. This points to the isobars cutting each other. When the temperature is so low that the vertex coincides with the zero of the field, all points lie in the negative region of w; that is, heating only takes place. Straight lines such as those assumed by Noell and Vogel are not isotherms. Here

V.2
192

in the region of observation, the deviation was smaller than the error of observation so that the parabolic form was not recognised. For the study of equal pressure curves and their dependence on temperature the equation is thrown into the form $(w + \mathrm{C})\,\mathrm{T} = -\,\mathrm{B}p^2 + \mathrm{A}$. The w, T lines are thus hyperbolas whose axes are the w-axis and are parallel to the T-axis at a distance C. For feeble pressures p may be put $= 0$, and the semi-axis of the hyperbola becomes equal to A. It decreases as the pressure increases, and when $\mathrm{B}p^2 = \mathrm{A}$, the hyperbola coincides with the axes. At high pressures the w-axis becomes negative, and in consequence, only heating occurs. The observations at low pressures by Noell and Bradley and Hale support these deductions, but at high pressures a curvature arises which contradicts the hyperbola, and is a consequence of a change in the specific heat. Taking this into account by writing $w\mathrm{C}_p$ instead of w, the hyperbolic curve is again established and a new equation of state derived, namely: $v = \mathrm{RT}/p - a/\mathrm{T} + hp^2/\mathrm{T} + \mathrm{C}$. This is compared with van der Waals' equation, and discussed at considerable length.

Further development is promised for a later date. H. H. Ho.

1308. *A Dynamical Method for Raising Gases to a High Temperature without the Use of High Pressures.* **W. H. Watkinson.** (Engineering, 110. p. 276, Aug. 27, 1920. Paper read before the British Assoc., Cardiff, Aug., 1920.)—If air be allowed to flow from the atmosphere through a spring-loaded wire-drawing valve adjusted so that the air in the cylinder during the charging stroke is constant at a pressure of ¼ atmos., and if this air is subsequently compressed to atmospheric pressure, then, neglecting the effect of clearance in the pump cylinder, the absolute temp. of this air at the end of the compression will be approximately 1½ the abs. temp. of the outside atmosphere, *i.e.*, $\mathrm{T}_c = 1\tfrac{1}{2} \times 288 = 432°$ abs. when the atmos. temp. is 15° C. The reason for this is that the constant-pressure line is approximately an isothermal line for the varying mass of air in the pump cylinder, and the temp. of the air during the charging stroke is approximately the same as that of the outside atmosphere. The connection between temperature, pressure, and volume of a given mass of gas undergoing expansion or compression is given by the equations: $\mathrm{T}_c/\mathrm{T}_b = (p/p_b)^{\frac{n-1}{n}} = (\mathrm{V}_b/\mathrm{V}_c)^{n-1}$, so that the absolute temperature ratio depends on the absolute pressure ratio, and not on the magnitudes of these pressures. A pump arrangement is described in which air from the atmosphere is admitted to the pump cylinder by means of a wire-drawing valve, and this air, after compression, is discharged through a valve into a receiver whose temperature under the conditions described will be 432° abs. If this air is then admitted to the other end of the cylinder, and is wire-drawn during admission to ¼ atmos. and then compressed to atmospheric pressure, the temperature will have reached $288 \times (1\tfrac{1}{2})^2 = 648°$ abs. If it were possible to use 5 such double-acting pumps arranged in series, the temperature of the air leaving the last pump at atmospheric pressure would be 16,600° abs., if the process could be carried out under the conditions assumed for the first stage. The temperature of the air leaving the second pump would be approximately 1460° abs. which is probably the upper limit at which the pump could be made to operate with present materials and types of compressors. The author describes this multi-stage wire-drawing method as a thermodynamic ratchet, and the paper is concerned with its possible applications. H. H. Ho.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

1309. *Contributions of Polarisation and Magnetisation Electrons to Electric Currents.* **A. D. Fokker.** (Phil. Mag. 39. pp. 404–415, April, 1920.)—It was suggested by Minkowski that the evaluation of the electric current due to the motions of the electrons of electrically neutral atoms might be effected by treating the question as a variation of a current by small virtual displacements, and the suggestion was worked out by M. Born [Math. Ann. 68. p. 526, 1910]. It is here developed further by comparatively simple means. A stream of neutral atoms is assumed for simplicity to consist of a positive nucleus and single electron. The motions of the heavy nuclei will be identified with the motion of matter, and it may be assumed that neighbouring atoms will be very nearly similar and similarly situated, so that the functions defining the positions of the electrons relative to their nuclei, though not strictly constant, will vary but slowly. The combined effect of the nuclear and electronic streams will be the current required in the field equations for ponderable matter. The problem will be solved if, given the displacements, the resulting variation of the intensity of the stream can be determined and interpreted in terms of physical quantities. The displacements are regarded as depending on a differential parameter θ, and the first and second variations are evaluated and interpreted; and it is found that the terms in the result proportional to θ are connected with the polarisation, while those proportional to θ^2 express mainly the effect of magnetisation. The interpretation of the results is greatly facilitated by the fact that each of the variations is related by a differential operator to a tensor, in that when the components of these tensors are set out in their respective schemes, the components of the variation can be separated into groups consisting of the components of physically recognisable vectors. The first variation furnishes a polarisation current $-\operatorname{div}.\ \dot{\mathbf{p}}$ with the corresponding Röntgen current rot $[\mathbf{pw}]$, together with a polarisation charge representing a contribution of the bound electrons, apparently not previously noted. Here $\mathbf{p}$ is the three-dimensional polarisation vector, $\mathbf{w}$ the material velocity, while $[\mathbf{pw}]$ is the well-known Röntgen vector, the three-dimensional vector product of the polarisation into the material velocity. The second variation furnishes the well-known magnetisation current c rot $\mathbf{m}$, where $\mathbf{m}$ is the magnetisation vector, a polarisation current $\dot{\mathbf{n}}$, the Röntgen current rot $[\mathbf{nw}]$ corresponding to the complementary polarisation $\mathbf{n}$, a current rot $\mathbf{k}$, where $\mathbf{k}$ is a vector analogous to the Röntgen vector which accounts in its curl for the second-order influence of the motion of polarised matter on the current, and finally the charge $-\operatorname{div}\mathbf{n}$, the second-order contributions of the bound electrons. The author observes that the current rot $\mathbf{k}$ is neglected because of its smallness in the deductions of Lorentz and Cunningham, and Born has not separated it from the magnetisation current. He suggests that perhaps its action might be detected experimentally if a rotating sphere of insulating material were surrounded by a fixed circuit about its equator and placed in a strong homogeneous electric field with the lines of force parallel to the plane of the equator. An oscillating rotation of the sphere should induce an oscillating current in the circuit. The covariancy of the equations obtained in the sense of relativity theory is demonstrable without difficulty. G. W. DE T.

1310. *Electrical Conduction by Free Electrons and Carriers.* III. *Migration Velocities of Particles forced through Friction Media.* **P. Lenard,** with contributions by **W. Weick** and **H. F. Mayer.** (Ann. d. Physik, 61. 8. pp. 665–741, May 4, 1920.)—The present paper is a continuation of a previous communication [see Abs. 259 (1920)], commencing with Section 6, wherein the migration velocities of particles are investigated for different cases of the behaviour of the medium molecules at the particle surface. The latter, in addition to the case of elastic reflection, also includes the entrance by diffuse reflection of the medium molecule into the surface layer of the particle with subsequent expulsion. The possibility of this occurrence and its characteristics have already been dealt with in Section 5. A survey of existing knowledge with respect to migration velocity formulæ is given in Section 7, the standpoint being that of historical evolution and including applications. Section 8 investigates the region of validity of the gas kinetic and the hydrodynamic migration velocity formulæ, together with their mutual relationships. The Stokes-Kirchhoff equation is first examined, and, for the spherical case, involves the condition that the spherical radius must be very great compared with the mean free path of the medium molecule. Cunningham and MacKeehan's extension of the latter formula next receives attention. Following this comes an examination of the gas kinetic equation, and a comparison with the hydrodynamic solution. The transition from the gas kinetic to the hydrodynamic equation with increasing particle radius is then derived. Section 9 deals with liquid media. Here is shown the extent to which the gas kinetic treatment is applicable, and its limitations as well as those from the hydrodynamic standpoint are discussed. Considerations are also advanced with respect to friction procedure in liquids, and experiments are described concerning friction in the electric field. The results are utilised for an exhaustive investigation of electrolytic ions, and lead to an inquiry into their radii and water content. Ionic nuclei and water molecules are found to be partly orientated under circumstances which produce strong contraction of the combination. Section 10 contains a summary of the migration velocity formulæ from Parts I to III of these investigations. H. H. Ho.

1311. *Ballo-Electricity, Molecular Force, and Electric Force.* **J. Traube.** (Ann. d. Physik, 62. 2. pp. 165–172, May 28, 1920.)—For the old term "waterfall-electricity" as used by Lenard, Christiansen proposes the word ballo-electricity, and he distinguishes the various results obtained from various materials by the terms (1) *aballish,* (2) *kataballish,* (3) *anaballish,* and (4) *hyperballish.* Thus: (1) Solutions of salts, also many acids and bases, which give no charge to the Pt plate on which they fall, are *aballish.* (2) Water and water solutions of oils, which charge the platinum +, are *kataballish.* (3) Solutions of quinine, aniline, and other organic compounds, which charge the platinum −, are *anaballish.* (4) Mixtures of the first group with a material of either the second or third group show greater ballo-electricity than either of the components of the mixture; these are *hyperballish.* The author suggests that the ballo-electric behaviour of all materials runs parallel with their surface tensions; small surface tension goes with small ballo-electric power, and so on. In justification of this view tables are given showing the ballo-electricity and surface tension of a variety of acids and alcohols. Thus oxalic acid has characteristic 0·1 volt and 7·24 c.g.s. surface tension; whereas acetic acid with 0·5 volt has 6·81 c.g.s. surface tension. Again, butyric acid has values 2·85 volts and 4·89 c.g.s.

The author finds not one exception to this general relationship, that ballo activity and surface activity go together. P. E. S.

1312. *Dynamical Motions of Charged Particles.* **C. G. Darwin.** (Phil. Mag. 39. pp. 537–551, May, 1920.)—The object of the paper is to obtain a general method of dynamical formulation of the motion of any number of changed particles, moving at high velocities in any electric and magnetic field. Here the velocities and not the momenta corresponding to the various generalised coordinates are the quantities known, with the one exception of a single particle in a fixed electric field, and no magnetic field. Hence the Lagrangian must be found before it is possible to proceed to the Hamiltonian, and the former will obviously not have the simple connection with the kinetic and potential energy of ordinary dynamics. Instead of the more elegant method of starting from least action—which Maxwell has shown to be applicable to the ether, so that it would be necessary only to prove that the electric and magnetic forces in free space could be made ignorable by the addition of suitable terms for the particles—the author takes the more elementary and therefore more widely accessible course of starting from modified Newtonian equations of motion, beginning with the case of one body and then extending. The problem is really one of relativistic dynamics, but making the mass of each particle the proper functions of the velocity, and using the electromagnetic equations in Lorentz's form, the motions described will be invariant for such transformations. This greatly simplifies the analysis. Since retarded potentials are required when several particles are free to move, approximation is requisite and the Lagrangian must not be expected to be accurate beyond the terms in C^{-2}. This necessity was to be expected in that, according to the classical electromagnetic theory, an accelerating electron will radiate, and the consequent dissipation of energy cannot possibly be represented by a Lagrangian form. The Hamiltonian is derived from the Lagrangian in the usual manner, and all the developments of general dynamics follow, except such theorems as depend on the kinetic energy having a quadratic form. The results are applied to the "Problem of two Bodies," and to Bohr's theory, using Sommerfeld's quantum relations [Ann. d. Phys. 51. p. 1 (1916)].

It was not to be expected that any effect perceptible experimentally for the distribution of lines in the H spectrum would be indicated, but the extreme smallness of the effects of the finite mass of the H nucleus is interesting. There are slight alterations in Balmer's constant, obtained by Sommerfeld, and a minute shift of the whole position of the composite lines. But the fine structure of each line remains absolutely unaffected.

G. W. DE T.

1313. *Ionisation in the Highest Layers of the Atmosphere.* **W. Hammer.** (Phys. Zeits. 21. pp. 218–219, April 15, 1920.)—Discusses the possibility of ionisation owing to impact of the highest layers of the atmosphere with gaseous material in space outside it, showing that the speed of the earth in its orbit is sufficient to produce this, *e.g.*, in the case of hydrogen molecules, and pointing out that on a given meridian the max. effect would be at 6 a.m. local time, and thus not the same as for ionisation produced by solar radiation. It is suggested that some of the phenomena of atmospheric and terrestrial electricity might be explained by this effect. M. A. G.

1314. *Diurnal Variation of Atmospheric Potential at Algiers.* **F. Baldet.** (Comptes Rendus, 170. pp. 818–820, March 29, 1920.)—Five years' records from an instrument 340 m. above ground are discussed. Disturbed days being neglected, hourly values of potential gradient are tabulated for the remaining 836 days, in order to investigate diurnal variation. The mean monthly curves group themselves, according to form, into three sets: winter, Nov. to Feb.; summer, May to Aug.; and equinoctial March, April, Sept., Oct. The mean curve for each set is subjected to harmonic analysis. Results: (1) Diurnal variation is sensibly a simple oscillation with a constant minimum about 4 h. and a maximum varying with the season. (2) The first harmonic has the same phase all the year, but amplitude in winter double that in summer, while the second harmonic has constant amplitude but a phase variation of 1 h. 6 min. (3) Maximum is markedly diminished in summer, but the nocturnal minimum and the mean daily value undergo no seasonal change. A relation $A = -0{\cdot}094\,T + 1{\cdot}72$ is found to exist, where $A = (\text{max.} - \text{min.})/(\text{mean})$, and T is the time the sun is above the horizon but retarded about 15 days. [Errata, *Ibid.*, p. 1136, May 10, 1920.] M. A. G.

1315. *Ion-Wind.* **V. F. Hess.** (Akad. Wiss. Wien, Ber. 128. 2a. pp. 1029–1079, 1919.)—If the air between the two plates of a condenser is ionised and an electric field applied, an air wind will normally be produced in such a direction as to move from places of weaker ionisation. This phenomenon which was demonstrated qualitatively by Zeleny for X-ray ionisation (1898) and studied by Ratner (1914) for α-ray ionisation, has been explained on the assumption that the air particles become charged by the ions and move in the electric field, thus creating what is usually termed an "ion-wind."

The author examines the effect of voltage and other controlling factors on the wind-pressure. It is shown that the decay of radio-active substances can be measured by observing the fall of wind-pressure with time. Measurements of the absolute value of wind-pressure, in dynes/cm.^{2}, have been made in the case of a polonium preparation.

The "wind" pressure is proportional to the intensity of the electrostatic field. A. B. W.

1316. *Atmospheric Electricity.* **E. v. Schweidler.** (Akad. Wiss. Wien, Ber. 128. 2a. pp. 947–955, 1919.)—A theoretical discussion is given of the number of mobile and heavy ions and of uncharged nuclei existing in a state of equilibrium in an ionised gas. From the theory it appears that, for small values of the ionising power q, the simple formula $q = \beta n$ serves to give the ion-content n with sufficient accuracy, where β depends to a first approximation only on the number of absorption centres present.

Experimental determinations of the value of β gave results from $21{\cdot}8 \times 10^{-3}$ to $16{\cdot}6 \times 10^{-3}$ sec.$^{-1}$ for open rooms, and a result $42{\cdot}2 \times 10^{-3}$ sec.$^{-1}$ for a hot room. The ion-content is consequently considerably below the value calculated for a given ionisation strength without taking account of the absorption centres. [See Abs. 1006 (1920).]
A. W.

DISCHARGE AND OSCILLATIONS.

1317. *Theory of the Glow Current.* **R. Holm.** (Phys. Zeits. 21. pp. 296–299, June 1, 1920.)—The two main points dealt with are the intensity measurements in the spectra of the glow border as investigated by Seeliger and Pommerrenig [Abs. 1540 (1919)], and the calculations on the kathode-fall as published by C. A. Skinner. The so-called "similarity law" of the author is also briefly dealt with. A. E. G.

1318. *Electric Figures.* II. **K. Przibram.** (Phys. Zeits. 21. pp. 480–484, Sept. 15, 1920.)—Using a similar method to that of Pedersen [Abs. 1092 (1920)] it was shown that in the production of electric figures the negative discharge has an advantage over the positive discharge, the negative figure being produced before the positive. An investigation is described of Lichtenberg figures in air and the gases N, H, O, CO_2 and Cl. [See Abs. 1319 (1919).] A. W.

1319. *Polarisation in the Geissler Discharge.* **E. Rumpf.** (Ann. d. Physik, 62. 2. pp. 173–184, May 28, 1920.)—A continuation of the work described in a previous paper [Abs. 1230 (1919)]. It is concluded, as the result of the present experiments, that the polarisation appearance set up in the Geissler discharge is essentially due to layers formed on the surface of the electrodes, which layers act as a capacity. The results previously obtained are thus confirmed. A. E. G.

1320. *Criticism of the Migration Velocity Formula proposed by Langevin.* **H. F. Mayer.** (Ann. d. Physik, 62. 4. pp. 358–370, June 17, 1920.)—The author first describes previous work on the migration velocities of particles forced through gases. The earliest investigation, which refers to a particle of any prescribed minuteness, and is based on the kinetic theory of gases, was made by Lenard [Abs. 97 (1901)], who evolved by simple means a general migration velocity formula for electrical carriers in gases. Two further publications appeared in 1913 and the most recent one in 1919 [see Abs. 259 (1920)]. Opposed to Lenard's results are those obtained by Langevin in 1903 and 1906. The present investigation attempts to discover the source of the difference between the two theories.

The main consideration which underlies both the work of Lenard and Langevin is as follows: A particle moving through a gas loses a definite amount of its velocity at every impact with a gas molecule. In the stationary state this velocity loss is just compensated by the velocity-increase which the particle acquires from the external force during the time between two consecutive impacts. As a consequence, the velocity of the particle in its free path is not uniform but accelerated, a circumstance which is of great importance for the mathematical solution of the problem. Notwithstanding the identity of the basic ideas in both theories, there is a difference of attack in that Lenard studies the migration velocity directly, whilst Langevin approaches indirectly *via* the velocity of diffusion. The present author points out the essential difference between these two velocities, in that for diffusion the motion of the particle along the free path is uniform, while the migration velocity is accelerated. This fact was not taken into account by Langevin, and constitutes one of the sources of difference between the two final results. The present paper is a mathematical exposition of this divergence. H. H. Ho.

1321. *Reaction Time of Contact Detectors.* **R. Ettenreich.** (Akad. Wiss. Wien, Ber. 128. 2a. pp. 1169–1200, 1919.)—Various substances are mentioned which when placed in point contact with each other, under pressure, provide next to the thermionic valve, the most sensitive method of rectifying and detecting high-frequency oscillations. The application of such detectors in wireless telegraphy is described.

Controversy regarding the exact mode of action of contact detectors is as old as their discovery. Their deviation from Ohm's law has been explained upon thermoelectrical grounds; but the problem is by no means solved, as other effects, such as electrolysis, undoubtedly occur. The author proposes to investigate whether the deviation from Ohm's law is due to the secondary e.m.f. or whether the resistance is a function of the applied voltage, in which case the current i through the contact being a function of the voltage, we may write $i = f(v)$ and if Ohm's law is obeyed $f(v) = v/r(v)$ and, if the resistance r is a function of the applied voltage, $f(v) = (v + v_1)/r$, where r is constant and the secondary voltage v_1 is a function of v.

It is probable that in the case of the secondary e.m.f. there is a time lag between the application of the exciting e.m.f. and the occurrence of the secondary e.m.f., as well as a time lag between the removal of the exciting e.m.f. and the decline of the secondary voltage and current. This time lag, regarded as exponential, may be written $v = v_0 e^{-t/R}$, where v_0 is the voltage at time t. From this expression the reaction time, R, can be defined as the time necessary for the secondary voltage to fall, after interruption of the exciting voltage, from its original value to $1/e$ times this value. Interruption of this voltage by mechanical means is practically impossible, but this difficulty can be overcome by the use of an alternating voltage of periodicity T, in which case we have two limiting cases: (1) the reaction time is small as compared to the periodic current variation (*i.e.*, $R \ll T$), in which case the current value of the alternating voltage corresponds to the direct-current characteristic, dynamical and statical characteristics being identical; (2) the reaction time is very great in comparison to the time of oscillation (*i.e.*, $R \gg T$) in which case the secondary e.m.f. cannot follow the alternating e.m.f., but this has a mean value on which the d.c. component is superimposed. The statical characteristic is now inapplicable. Ohm's law is obeyed, and very rapid sine voltages give a pure sine current. This case corresponds to the thermoelectric view for which the current variation is so rapid that during a single oscillation no great temperature variation has time to occur at the contact point. On this view, the reaction time R must be small in comparison with the spark frequency, but large as compared to the time of each oscillation.

Between these limiting cases is the more complicated case when R is of the same magnitude as the half-period of the applied alternating e.m.f. and lag effects of the secondary e.m.f. with respect to the applied e.m.f.

occur. The two limiting cases and the intermediate case are all illustrated and explained graphically. In order to determine the magnitude of the reaction time the author has investigated the lag and also the variations of the crystal characteristic with frequency.

The actual apparatus used to investigate the upper limit of the reaction time, utilised two thermionic valve generators, separately coupled to an intermediate circuit and hence to a wavemeter circuit, in which the normal detector was replaced by a suitable galvanometer, shunted by a 10-mfd. condenser. The detector under investigation was situated in the intermediate circuit and could be shunted by a key, which when closed permitted the two wave-lengths λ_1 and λ_2, and hence frequencies v_1 and v_2 of the valves to be detected in the wavemeter. When opened, beat formation occurred and the beats due to $v_1 - v_2$ could be detected in the wavemeter as well as the wave $\lambda_1\lambda_2/(\lambda_1 - \lambda_2)$. Each beat causes a direct current in the wavemeter galvanometer, so that the reaction time R of the detector cannot be greater than the beat periodicity. By varying λ_1 and λ_2 any desired beat frequency, between wide limits, can be obtained. Inaccuracies of this method are mentioned, such as variations due to the use of different wavemeter inductance coils to measure widely separated wave-lengths.

The results of measurements with galena-nickel and "perikon" (zincite and chalcopyrite) detectors give a value for R less than or equal to 2×10^{-6} sec.

Apparatus for investigating the statical characteristic is then described. This consisted of a bridge arrangement having a coarse and a very fine adjustment of resistance, and the current in the galvanometer was recorded photographically. For the characteristic obtained with this apparatus an expression $i = a(e^{bv} - 1)$ is found to hold for all ranges around the origin and agrees with results due to Owen. These characteristics are divisible into four portions: two extreme non-rectifying portions, a non-rectifying flat portion, and a parabolic rectifying portion.

Difficulties in the practical application of the oscillograph or Braun kathode tube for the investigation of very rapid oscillations are mentioned, although it is suggested that a Braun kathode tube with a heated kathode and long kathode-beam might be used. The experiments of Pierce with the kathode tube for the low frequency of 50 per sec. are mentioned; but as he used a relatively heavy current, the detector was overloaded and his oscillographs show no lag effect, as the experimental accuracy was only 1/6000th of a second, *i.e.*, above the reaction time.

The author alternatively proposes to investigate the phenomena by the use of a Fourier's series of the type

$$i = i_0 + i_1 \cos(t + t_1) + i_2(2t + t_2) + i_3 \cos(3t + t_3) + \ldots \text{ etc.},$$

in which the constant factor can be directly measured and the amplitudes and coefficients of the harmonics can be determined by use of the wavemeter. The analysis of the d.c. component as a function of applied voltage amplitude and frequency, with and without the application of a steady voltage by means of a crystal potentiometer, are dealt with in this paper, whereas a further paper is to deal with the harmonics and observations carried out with a Helmholtz pendulum interrupter.

Apparatus of the bridge type for investigating the variation of the d.c. component with amplitude and frequency are then described in detail, with expressions for the inductance, resistance, and skin-effect of the apparatus. A large number of observations have been so made, of which typical examples are given for the galena-nickel and perikon detectors. Considering the d.c. component to be independent of the frequency, the value for reaction time is again found to be smaller than 10^{-6} sec.

The effect of a steady potentiometer voltage for the same two detectors is dealt with for negative and positive voltage values. From the experimental results by employing a frequency of 10^6 per sec. the reaction time is again found to be below this limit.

Various conclusions of practical importance are finally mentioned; for example, for reception of small-voltage-amplitude signals that detector is most advantageous of which the statical characteristic has the smallest radius of curvature. Also the smallest radius of curvature should not pass through the origin, in which case reception can be improved by the use of a potentiometer. It is also pointed out that whilst the steady resistance of most contact detectors is high (PbS/Ni = 15,000 ohms; perikon = 3000 ohms), low-resistance detectors are to be preferred.

B. J. L.

1322. *A Beat Method to Test the Reaction Lag of Contact Detectors.* **R. Ettenreich.** (Phys. Zeits, 21. pp. 208–214, April 15, 1920.)—Much of this paper is a repetition of a previous paper [see preceding Abstract] except that the apparatus used is described in greater detail. Essentially the experimental method is to utilise two thermionic valves of slightly different oscillatory frequency in order to produce audible beats, the frequency of which can be varied over a wide range by adjustment of the generating valves. Such beats are rectified by a crystal detector, and by means of a coupling, the d.c. component is measured with the galvanometer of a wavemeter.

Experimental data are given regarding investigations of frequency up to $5{\cdot}09 \times 10^6$ per sec. The beat waves are found not to be pure sine waves, but have harmonics of multiple frequency.

The detector used was a galena-nickel combination, and the author considers this detector can follow current variations of duration only two ten-millionths of a sec., which result, he considers, prejudices the thermoelectric view of the detector phenomenon. [Corrigendum, *Ibid.*, p. 360, July 1, 1920.]

B. J. L.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

1323. *Electric Contacts.* **H. Rohmann.** (Phys. Zeits. 21. pp. 417–423, Aug. 15, 1920.)—A torsion arrangement is described by means of which displacements of the order of 1 $\mu\mu$ could be determined. With this apparatus the variations of current, due to closer approach of the electrodes of a contact, could be followed. The "contact distance" for different materials was of the order of magnitude of 1–50 $\mu\mu$. The results made it possible to produce an efficient metal microphone and a reliable coherer. It was also found that the electrolysis of metal salts between two electrodes of different size and near to one another, produces a certain amount of rectification.

A. W.

1324. *The Thermoelectric Power of Pure Metals.* **H. Pélabon.** (Ann. de Physique, 13. pp. 169–187, May–June, 1920.)—Observations were made upon pure metals whilst one junction was kept at an ordinary temperature whose constancy was verified by means of a sensitive iron-constantan couple, the other being raised by means of an electric furnace to successive high temperatures which reached values considerably above the melting-points of the metals. The following systems were tested; the results are given in the form of curves or tables showing the thermo-e.m.f. at successive temperatures: Pt-Pb, Pt-Sn, Pt-Bi, Pt-Sb, Pt-Th, Pt-Zn, Pt-Cd, Pt-Al, Pt-Ni, Pt-Cu, Pt-Ag. The results reached by the experiments were that: (1) The thermoelectric power of the pure metals varies in a continuous manner with the temperature. (2) There is no discontinuity at the point of fusion. (3) For the metals in the liquid state the thermoelectric power varies linearly with temperature, at least for Pb, Sn, Bi. In the case of Sb the results are more complicated. J. J. S.

1325. *Thermoelectric Effect in Mercury when heated Asymmetrically.* **C. Benedicks.** (Ann. d. Physik, 62. 3. pp. 185–217, June 8, 1920.)—By the aid of an ironclad [Panzer] galvanometer [1 mm. deflection for $4 \cdot 8 \times 10^{-9}$ volt at scale distance of 1·5 m.] the author has succeeded in measuring the e.m.f. in a column of mercury when asymmetrically heated. Constricted tubes of various materials (slate, glass, asbestos) were used to contain the mercury, heat being applied at one side of the constriction. Full details of the apparatus are given in the paper, and the various precautions taken to avoid spurious effects are described. The e.m.f. was found to be proportional to the cube of the temperature difference on the two sides of the constriction. The order of the effect was $3 \cdot 5 \times 10^{-8}$ volt for a temperature difference of 97·5 deg. C. The direction of the e.m.f. conforms with that required by theory. The interpretation of Haga and Zernicke's experiments with mercury jets is also criticised [see Abs. 146, 147 (1920)]. L. L.

1326. *The Thermoelectric Effect in a Homogeneous Conductor of Uniform Section.* **C. Benedicks.** (Comptes Rendus, 170. pp. 1382–1385, June 7, 1920.)—Discusses the view taken in a previous paper [see Abs. 81 (1919)] that when a current traverses a conductor with a uniform constriction the heat transport is such that the temperature difference between the two sides of the constriction is proportional to the current passing. L. L.

1327. *Experimental Researches on the Electrical Deformation of Dielectrics.* **B. L. Bouchet.** (Ann. de Physique, 12. pp. 303–442, Nov.–Dec., 1919.)—The length of this paper does not permit of a detailed abstract. The author first gives an historical survey of the subject, after which the work is divided into the following sections.

1. Action of an electrostatic field on solid dielectrics deformed (i) in a direction perpendicular to the field, (ii) in the same direction as the field, when the plates of the condenser are (*a*) in contact with the dielectric, (*b*) separated from the dielectrics (glass, paraffin, ebonite).

The elastic properties are studied at the same time for mechanical deformations of the same order as those given by the electric field.

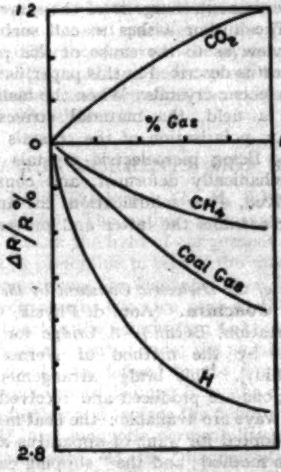
2. Action of the electrostatic field upon the interior volume of insulating cylinders (ebonite, rubber). Here also mechanical deformations are studied.

3. Action (in the direction of the field) upon liquids. If the medium be a conducting liquid (water, mercury), equilibrium between the electrostatic field and the motion of the liquid is instantaneous. For liquid insulators (vaseline, oil, benzene, petroleum ether) the instantaneous charge is followed by a slower one. For these liquids and also for ebonite and rubber, the variation of dielectric coefficient with time is measured, and it is shown that the variation of capacity and the slow increase of deformations have the same cause.

For the description of the numerous experiments performed and their theoretical discussion reference should be made to the original paper.

T. H.

1328. *Change of the Electrical Resistance of a Metal Wire in Atmospheres of Mixed Gases.* **M. So.** (Phys.-Math. Soc. Japan, Proc. 2. pp. 118–125, June, 1920.)—The author has measured the electrical resistance of a thin Pt wire 0·088 mm. thick and 100 cm. long, sealed in a glass bulb in an atmosphere of a binary gas mixture. The components of the mixture and their relative proportions could be altered. The temperature of the wire was also varied by the passage of an electric current. The bulb was placed in a Dewar vacuum vessel and the effect of change in the surrounding temperature studied. The gas mixtures employed were (1) air and H, (2) air and CH_4, (3) air and coal-gas, (4) air and CO_2. The results obtained are given in a series of tables in the paper. The Fig. shows that in mixtures of air with H, coal-gas, or methane the resistance of the wire decreases with the percentage increase of the gas. With CO_2 the reverse effect is obtained. The author considers that there will be a greater change of resistance the greater the difference of diffusibilities of the components of the mixture; but in the case of methane the density may have a predominating influence. The higher the temperature of



the wire (range 14° to 49°) the greater is the change of its resistance. Raising the surrounding temperature also increases its resistance.

L. L.

1329. *Permanently Polarised Dielectrics.* **M. Eguchi.** (Phys.-Math. Soc. Japan, Proc. 2. pp. 169–176, July, 1920.)—Continuing work already published, the author shows that certain composite dielectrics behave differently from either constituent dielectric. Take one example. Neither beeswax nor resin (the former amorphous, the latter crystalline) if subjected to a strong electric field when melted and then solidified shows any permanent electric polarisation. But if they are mixed in equal proportions and subjected to this treatment, they have strong permanent polarisation after solidification. This polarisation is internal, since if the surface charge be removed by Bunsen flame, by X-ray exposure, by washing with reagents, or even by removing the surface itself with a knife, the surface charge is removed but returns again with the lapse of time. The duration of this permanent charge is of the same order as that of a permanent magnet. The author wishes to call such kind of dielectric an "Electret." His view as to the cause of this phenomenon (which is observed by an apparatus described in this paper) is that the electrification is caused by piezoelectric crystals When the melted wax, dissolved in resin, is cooled in a field, the material strives to crystallise in such way that the max. polarisation of the crystals coincides with the direction of the field. Being piezoelectric crystals they yield to the electric force, are mechanically deformed, and consequently charged. When the field is removed, after solidification, the amorphous wax surrounding the crystals constrains the latter and prevents them returning to their natural form.

P. E. S.

1330. *Determination of the Dielectric Constant by the Wheatstone Bridge at High Frequency.* **H. Joachim.** (Ann. d. Physik, 60. 6. pp. 570–596, Nov. 27, 1919. Dissertation, Berlin.)—A bridge for the determination of dielectric constants by the method of Nernst was described by Hertwig [Abs. 742 (1914)]. This bridge arrangement is used by the author, but the oscillations are produced and received by triode valves. For the reception three ways are available: the beat method, which would be best, but was not adopted for want of apparatus and because almost toosensitive; the audion method; and the "slipping contact" of the Telefunken Co., which was adopted. In this contact the telephone current is interrupted by a wheel with very fine teeth bearing against a spring and turned by clockwork; compensation is required for the phase distortion by the extra currents in the electrolytic resistance. Determinations of the electric current were made in nickel crucibles with ether, toluene, chloroform, o-xylene, anilin, ethylene chloride; in platinum crucibles with conductivity water, several alcohols, acetone, and nitro-benzene. Solids are powdered and compressed in nickel crucibles; the density of the powdered material is determined, and the dielectric constant observed is recalculated for the greater density of the same material in the original crystal. The substances tested are potassium chloride and potassium alum; lead chloride and acetate; sulphur; mercury chloride and cyanide; ammonium sulphate—determinations being made at + 17°, − 5, 20, 30, 45, 60, − 180°. A variation of the dielectric constant with temperature was not observed, though the observations of the specific heat of ammonium salts with

V.2
192

temperature [R. Ewald, Abs. 466 (1916)] made a variation probable; the method used was probably not sufficiently sensitive. These features and the desirability of high frequencies are discussed. H. B.

1331. *On the Existence of True Pyro-Electricity.* **K. F. Lindman.** (Ann. d. Physik, 62. 2. pp. 107–112, May 28, 1920.)—The question, whether there is a true pyro-electricity, *i.e.*, one produced entirely and only by change of temperature, or whether the pyro-electric excitation can be traced to the deformation of the crystal due to heating or cooling, is answered variously according to the values found for the thermal coefficient of expansion of the particular tourmaline used. Pfaff's value for this coefficient was used by Riecke and Voigt, and they found only 10% difference between the electricity due to pyro- and piezo-electricity. Using later the Pulfrich-Kelner value for this coefficient, on the other hand, Riecke and Voigt found a 20% difference.

The author applies a formula derived from Voigt's theory, the factors in which are the two pyro-electric moduli, and the two coefficients of expansion perpendicular to and parallel to the principal axis, and he finds the percentage difference between the pyro- and piezo-electric electricities to be only 12%. Allowing for possible systematic errors in the data used, the author considers that the existence of true pyro-electricity is not firmly established. P. E. S.

ALTERNATING CURRENTS AND MAGNETISM.

1332. *Magnetic Field Relations.* **G. H. Livens.** (Phil. Mag. 39. pp. 673–677, June, 1920.)—The author accentuates the contention now generally admitted, that in the light of our present knowledge of the electromagnetic field it is preferable to regard the magnetic induction as the fundamental force vector and the magnetic force H as the induced vector representing the mechanically effective part of the total magnetic force from which the local part in the polarisation $4\pi I$ has been rejected, H being therefore derivable from a potential under the usual appropriate conditions. That is to say H should be defined by the equation $H = B - 4\pi I$ in place of Maxwell's procedure of defining B by the equation $B = H + 4\pi I$. He would like to go further and replace the definitions of magnetic susceptibility κ by $I = \kappa H$, and magnetic permeability μ by $B = (1 + 4\pi\kappa) H = \mu H$, by the statement: If the magnetisation I is partly rigid (I_0) and partly induced (I_i) by the total force B, and if the induction follows a linear isotropic law, we should write $I_i = \kappa B$; and then $H = \mu B - 4\pi I_0$, where $\mu = 1 - 4\pi\kappa$. He would transfer the name magnetic permeability to the new μ, but does not state whether he suggests also the transference of the name magnetic susceptibility to the new κ.

G. W. de T.

1333. *Variation of Magnetic Susceptibility during Allotropic Transformations and Melting of some Substances.* **T. Ishiwara.** (Tôhoku Univ. Sci. Reports, 9. pp. 231–242, June, 1920. Thirty-fifth report of the Iron and Steel Research Inst.)—The torsion balance usually employed for measuring magnetic susceptibility was modified so that the specimen could be heated electrically *in vacuo* or in an atmosphere of inactive gas. The substances examined were AgBr, AgCl, S, Zn, and Al. AgBr is diamagnetic and in cooling from 500° C. its susceptibility remains fairly constant to 200°. Below this temperature it is slightly less diamagnetic, but this is probably due to the presence of minute quantities of paramagnetic impurities. No discontinuity occurs in passing through the melting-point. The chloride, which is also diamagnetic, behaves in a similar manner to the bromide. Sulphur is diamagnetic and showed no appreciable change at 96° C. (transformation from rhombic to monoclinic crystals), nor is there a definite discontinuity at melting (114·5° to 119°). At the range 160° to 170° (passage from the yellow mobile fluid to the brown viscous fluid) the susceptibility changes suddenly (diminution of diamagnetism) by about 2% and then remains constant on further heating. If sulphur is cooled rapidly from the brown viscous state a sudden but reversible change may occur at 80° C. The diamagnetic susceptibility of Zn decreases almost linearly with rise of temperature. There is an abrupt decrease of about 4% at the melting-point. Al is paramagnetic, and its susceptibility does not vary within the range of 100° below the melting-point. At fusion there is a slight increase of about 2%, and after that the susceptibility remains constant with further increase of temperature. L. L.

1334. *Change of Length by Magnetisation in Iron-Nickel and Iron-Cobalt Alloys.* **K. Honda** and **K. Kido.** (Tôhoku Univ., Sci. Reports, 9. pp. 221–231, June, 1920. Thirty-fourth Report of the Iron and Steel Research Institute.)—The change of length was measured by the rod under test causing a thin roller on which it rested to rotate, and thus a plane mirror attached to the roller was inclined through a small angle which was observed by means of a telescope and scale. The eyepiece of the telescope was removed, and a microscope of long focus with micrometer screw was used instead; one division of the screw was equivalent to an elongation of the specimen by $0 \cdot 76 \times 10^{-6}$ cm. The results are contained in tables and curves. With pure iron there is at first elongation followed by contraction when the field increases beyond 330 c.g.s. With pure nickel there is contraction with all fields. With iron-nickel, elongation takes place with all concentrations up to 77% Ni, after which there is contraction. Further, for fields of 150 and 500 the elongation–concentration curve exhibits two maxima of elongation at about 14 and 42% Ni. With iron-cobalt alloys the changes are somewhat similar. There is elongation with all fields until the concentration reaches 80% Co, when the elongation disappears in a field of 315 c.g.s. With 90% Co the field always causes contraction; similarly with pure Co. In the elongation–concentration curves for given fields, the two maxima are present in fields of 50 and 150 for concentrations of about 40% and 70% Co. In a field of 500 c.g.s. only the maximum for 70% Co persists. To explain the phenomena, forces causing elongation and contraction are supposed to exist simultaneously when a field is applied. Under their action, the elongation first becomes asymptotic and afterwards the contraction, as the field increases. [See also Abs. 1287 (1916), 257 (1917), 411 (1918), and 85 (1919).] G. E. A.

1335. *Magnetic Induction by Needles of Ship's Compass in the Soft-Iron Correctors.* **L. Dunoyer.** (Comptes Rendus, 170. pp. 1374–1376, June 7, 1920.)—The author has given an expression for the couple acting on the compass when correcting spheres of soft iron are placed in the neighbourhood of the compass [see Abs. 141, 1764 (1909)]. An error

V.2
192

in this expression has, however, been pointed out by Perrin, and the author gives the corrected form for the moment of the couple. The theory thus completed gives satisfactory concordance between the observed and calculated deviations of the compass. In the author's experiments the value of the induction is increased by one-third when the effect of the length of the needles is taken into account, an effect which cannot be neglected in any form of ship's compass. G. E. A.

1336. *The Corbino-Effect in Fused Bismuth.* **T. Collodi.** (N. Cimento, 19. pp. 163–172, April, 1920.)—The experimental arrangements are described and illustrated diagrammatically. From the results given it appears that the Corbino-effect in bismuth, in fields of medium intensity, decreases rapidly with rise of temperature and is finally reduced to zero at the point of fusion, remaining constantly nil in the fused metal.

A. E. G.

1337. *Diamagnetism of Bohr's Hydrogen Atom.* **J. R. Ashworth.** (Nature, 105. p. 516, June 24, 1920.)—The author has shown [Abs. 1063 (1913)] that a magnet in a uniform field, and free from the influence of other magnets will appear diamagnetic when vibrating more than ± 130°, or when the vibrations pass into rotations, and Honda [Abs. 85 (1919)] has confirmed the result, with certain assumptions as to the shape of the atom, on his kinetic theory of magnetism. It is here suggested that the H atom may be really paramagnetic and similarly exhibit *pseudo-diamagnetism*, as opposed to true diamagnetism due to induced electric currents in the atom. The former would vary with temperature and the atomic aggregation, the latter probably not. **A. E. Oxley.** (*Ibid.*, pp. 581–582, July 8, 1920.)—Numerous recent data indicate that the diamagnetism of H decreases as the temperature rises, whereas, Oxley argues, the reverse would be expected on Ashworth's view. The author's opinion is that the free H atom is probably paramagnetic, but that the structure of the H molecule is such as, by compensation, to render it, as a whole, diamagnetic. **J. R. Ashworth.** (*Ibid.*, p. 645, July 22, 1920.)—Ashworth argues that the decrease in diamagnetism as the temperature rises would seem to favour a kinetic origin, and the fact of there being any change is opposed to the accepted view of diamagnetism. Since the paramagnetism of a rotating magnet is found only for oscillations of less than 130°, the kinetic energy must be comparatively small, and in the case of H a change from diamagnetism to paramagnetism can be expected only at temperatures very near to the absolute zero. G. W. DE T.

RADIOGRAPHY AND ELECTROPHYSIOLOGY.

1338. *Problems of Interrupted and Fluctuating Currents.* **C. E. S. Phillips.** (Röntgen Soc., J. 16. pp. 94–95, July, 1920. Electrician, 84. pp. 289–290, March 12, 1920. Abstracts of paper read before the I.E.E., the Roy. Soc. of Medicine, and the Röntgen Soc. Feb., 1920.)—Since the p.d. between the electrodes of the tube determines the speed of the electron and therefore the quality of the X-radiation produced, the electrical problem resolves itself mainly into one of engineering. The p.d. necessary is, however, exceptionally high, and the machines and appliances require to be specially designed. Metallurgists require a machine that will give 300,000 volts. For instantaneous radiography in medical Institutes large currents are also needed at these high voltages. The induction coil has much to recommend it. The simplicity and absence of moving parts are great advantages. In the interrupter lies the principal limitation, and the troubles are divided between it and the condenser. The shape of the condenser is of importance; of two condensers with the same capacity, the one having long narrow leaves is not so effective as one in which the leaves are nearly square. One of the causes of coil breakdown during the war was fracture of the wax during transport. It is suggested that a fairly thin oil could be used as an insulator, thin enough to draw off before transport, and it should be possible to replace the oil without creating air cavities. The secondary could be wound with No. 36 Al wire and thus save one-third of the weight of Cu. An improvement from an Army point of view could also be effected by using a removable core. A coil so designed would be extremely portable on account of the distribution of weight. The weakest point of a coil outfit is undoubtedly the condenser. An alternative path should always be provided to carry off any excessive surges of current into the condenser. Recent experiments in this direction at the War Office X-ray Laboratory have shown that a condenser, while in use, may be short-circuited through a water resistance (3 in. of tap water, using fine Cu wires just dipped below the surface) with a reduction of only 20% of the coil output. Three 16-c.p., 250-volt carbon-filament lamps in series joined across the condenser terminals proves quite satisfactory. The value of the interrupted current that may be safely used with a coil is limited owing to the flare when the primary current is broken. Interrupters are frequently imperfectly designed and constructed. Experiments with tantalum blades are required, for in tests already made there is indication that flare can by this means be reduced. With transformers where very high-tension work is concerned and a rectifying disc is spun by a synchronous motor, the weak spot of the installation practically always seems to be the insufficient guarding of the armature windings from induced surges of current. Earthing through a condenser, or other means of assisting the insulation of the armature to withstand the strain put upon it, is essential. One serious objection to the transformer arises from the form of the secondary p.d. wave; a steeper p.d. wave is required. In 1895 Barr, Beeton, and Taylor published a paper in the *Electrician* dealing with the question of changing the shape of alternator wave-forms. They keyed to their experimental alternator a special commutator called by them an "injector" by means of which inductance or capacity, or both, could be introduced into the circuit at regular intervals. In this way remarkable distortion of the original wave-form was obtained without sparking. It is suggested that the wave-form of the current for the transformer be distorted synchronously by keying an "injector" to a small synchronous motor and connecting it in series with the main supply and the transformer. In this way a wave-form could be obtained which would render the rectifying disc unnecessary. The installation would not only be less costly, but would weigh less, occupy less space, and be highly efficient for the requirements of X-ray technique. A. E. G.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

1339. *Atomic Weight of Lead from a Japanese Radio-active Mineral.* **T. W. Richards** and **J. Sameshima.** (Am. Chem. Soc., J. 42. pp. 928–930, May, 1920. Chem. News, 121. p. 5, July 2, 1920.)—Lead separated from a crystalline mineral crust, containing also barium, occurring at the bottom of a hot spring at Hokuto, Formosa, is found to have the atomic weight 207·13, that of ordinary lead being 207·184. The lead is hence composed mainly of ordinary lead, with perhaps not more than 5% of isotope of lower atomic weight. T. H. P.

1340. *Melting-points and Thermoelectric Behaviour of Lead Isotopes.* **T. W. Richards** and **N. F. Hall.** (Am. Chem. Soc., J. 42. pp. 1550–1556, Aug., 1920.)—Among the properties of the isotopes of lead, the melting-points stand out as of particular interest. Since the molecular volumes of these substances are essentially equal, the question as to whether or not the melting-points are similarly equal, is of some importance. Thermocouples were used for this measurement, not only because they could be used with small amounts of material, but also because they are essentially suited to "differential" estimation.

The experiments described show that the difference in melting-points of two specimens of lead differing 0·8 in atomic weight is, if appreciable, not over 0·05 deg. C. From this outcome it is assumed that the two kinds of lead not only have very nearly the same melting-point, but also (since the sample consisted chiefly of the lighter isotope contained ordinary lead) they mix, or mutually dissolve, without affecting the melting-point.

The Seebeck thermoelectric effect produced at a junction of the two kinds of lead is also shown to be nil. A. B. W.

1341. *Chemical Effects of Penetrating Radium Radiations.* II. *Action of the Rays and of Ultra-violet Light on Toluene.* **A. Kailan.** (Akad. Wiss. Wien, Ber. 128. 2a. pp. 831–852, 1919.)—Exposing toluene and water in glass bottles charged with oxygen for one year to the sun's rays, Ciamician and Silber observed in 1912 that benzoic acid (12%) was formed and further benzaldehyde and formic acid. The author having found that ultra-violet radiations (quartz-mercury lamp) were nearly a thousand times more powerful in such reactions than radium rays [see Abs. 598 (1912), 714 (1913), 571 (1914), 444 (1919)], sealed up 100 $cm.^3$ of dry toluene in an Erlenmeyer flask, together with 118·7 mgm. of radium-barium chloride (in a glass bottle, 1 mm. glass thickness), and kept the flask in the dark (in the Institut für Radiumforschung) from April 1917 to Feb. 1919 (16,344 hours), together with a blank flask. In the first flask the toluene was subsequently found yellowish, density raised from 0·85954 to 0·85997; some benzoic acid was formed, but the main product was a yellow, very sluggish liquid; only 0·25% of the toluene had been attacked. In the blank flask the toluene had remained unchanged. In a second series dry toluene was for 22 hours exposed to the light of a quartz-mercury lamp at a distance of 8 or 9 cm.; the changes produced were qualitatively and quantitatively the same. In further experiments

50 cm.^{3} of toluene were enclosed together with 50 cm.^{3} of water. Benzoic acid, formic acid, and some non-acid residue were found, the amount of benzoic acid being 3 times larger than in the dry test with radium. Ultra-violet light (for 22 hours) again produced very similar changes; the acid formation was a little slower, but went further, since oxalic acid was also observed. The general result confirms previous observations that ultra-violet light was 700 times more powerful than the radium radiations. H. B.

1342. *Activation of Wood Charcoal by Heat Treatment.* **J. C. Philip, S. Dunnill,** and **O. Workman.** (Chem. Soc. J., Trans. 117. pp. 362-369, April, 1920.)—The main series of experiments was carried out with birch-charcoal, and the stock material was prepared by heating small cubes of the wood for three hours at 800.° The product was broken up and screened, the granules which passed through a 0·25 cm. mesh (0·1 in.), but were kept back by 0·125 cm. mesh (0·05 in.), being used in the tests. For a determination of the absorptive power a Jena-glass tube containing the charcoal was first exhausted at a dull red heat for a short time, and then, on cooling, the charcoal was weighed in a vacuum. The tube containing the charcoal was next put in position in the absorption apparatus, immersed in melting ice, the dead space (of known volume) between the appropriate stopcocks and the glass tube thoroughly exhausted, and the connection with the pump then closed. Sulphur dioxide in a gas burette was then admitted to the dead space and the charcoal, and equilibrium was allowed to establish itself at a number of different pressures, the volume of unabsorbed gas for each pressure being read off from the gas burette. The results obtained indicate that, in general, the absorptive power of the charcoal for sulphur dioxide increases with the duration of the period of heating, but further, that the period of heating is not the main factor in determining the degree of activation. This main factor seems to be the alteration in the bulk density which results from heating the charcoal. The lower the relative bulk density of the charcoal the greater is its absorptive power. It was proved conclusively that the greater the facilities for the access of air to the charcoal during the period of heating, the greater is the decrease of bulk density and the greater the increase in absorptive power. When a sample of charcoal which had been freed from air by a current of nitrogen was heated, both the absorptive power and the bulk density were practically unaltered. With the original, comparatively inactive stock of charcoal an increase of pressure above a certain value does not lead to any marked increase of gas absorption, whereas with the most active charcoals there appears to be no such limit: the slope of the volume-pressure curve becomes steeper as the activation increases. An explanation of this can be given on the assumption that the heating of charcoal results in the widening, by progressive oxidation, of the capillary channels with which the granules are riddled. A charcoal of low activity has extremely narrow capillaries, and the deposition of a comparatively shallow layer of gas molecules on the surface will block the capillaries and cut them off from further participation in the absorption process. In an activated charcoal, on the other hand, the capillaries have been opened up, and the deposition of additional gas molecules accompanying an increase in pressure can proceed along the walls of their internal capillaries as well as on the free surface of the charcoal.

The increase in the absorptive power of wood charcoal for gases effected by continued heating is parallelled by a marked increase in the power of the charcoal to remove methylene-blue from its aqueous solution. This was shown to be the case with Japanese ash charcoal and with animal charcoal. For example, a sample of animal charcoal removed 17·8% of methylene-blue from solution, but after heating for 18 hours at about 800° it removed 69·6 %. Special charcoal preparations, such as ebonite, exhibit similarly a big increase of decolourising power as a result of heat treatment. The activity of the charcoal can be correlated neither with its nitrogen content, nor with the presence of specific inorganic constituents in the ash; the increase of activity is associated with a diminution in the bulk density. It appears to be necessary to heat the wood or charcoal to a temperature of 800° or above to bring about activation. Although light woods are activated more rapidly, they are ultimately surpassed in activity by charcoal derived from denser woods, such as box. Experiments to determine whether heat alone, apart from oxidation, would lead to any change in the decolourising power of charcoal were not conclusive. [Compare Abs. 494 (1919).]

T. S. P.

1343. *Nature of the A1 Transformation and a Theory of Quenching.* **K. Honda.** (Tôhoku Univ., Sci. Reports, 81. pp. 181–205, Dec., 1919. Iron and Steel Inst., J. 100. pp. 417–438; Corres., 439–443, Sept., 1919.)—Martensite is a solid solution differing in phase from austenite, the heat evolution on the change from austenite to martensite for a 0·8% carbon steel being 4·2 cals. There are two forms of martensite: β, which is first formed from austenite and is the more dilated, and α which is subsequently produced from the β and is more easily tempered and etched. On heating, the reverse change occurs, Pearlite ⟶ sorbite ⟶ troostite ⟶ α martensite ⟶ β martensite ⟶ austenite. On quenching, the change from austenite to martensite is not prevented, but merely lowered to the vicinity of room temperatures, when further changes to troostite, sorbite and pearlite are arrested. A dilatometer is described by means of which the volume changes resulting from quenching are measured. The dilatometic curves for the tempering of martensite show two steps at about 170° and 340° C. After oil-quenching, volume changes gradually occur, the sign of which is dependent on the carbon content of the steel. For low-carbon steel this is an expansion, for high-carbon steel a contraction. A steel of 0·75 % carbon at first elongates and then contracts. F. C. T.

1344. *Crystallography of Alpha and Beta Iron.* **F. Giolitti.** (Chem. and Met. Eng. 22. pp. 585–589, March 31, 1920.)—Gives a classification of the various microscopical appearances of hypo-eutectoid steels, after varying rates of cooling with and without mechanical work for totally equalised and partially equalised metal, based on the hypothesis that β iron assumes a granular, and α iron a laminar habit. The conclusions are mainly based on the results of the microscopical examination of a sample of sheet steel which had formed part of a heat-treatment muffle that had been constantly between 900° and 1050° for five months and had required 4½ days during cooling to drop from 1000° to 150°. As the interior of the muffle had been filled with wood charcoal and the exterior surrounded by oxidising gases, the carbon varied uniformly from about 1% on the inside to nil on the outside.

All cross-sections of this steel plate exhibited two distinct forms of ferrite crystals: one, characteristic of regions containing less than 0·4% carbon, where the ferrite existed in rounded grains common to ordinary soft steel, and the other characteristic of higher carbon regions where the ferrite existed as needles in concordant groups, an appearance common to the Widmanstättian structure. The rounded particles of ferrite separated from austenite as β iron at temperatures above 760°, whilst the plate-like laminations separated directly as α iron at or below 760°. Should the crystallisation process be disturbed by forging or other mechanical work, a barrier would be presented to the deposition of the α plates upon the β granules, copying and preserving the rounded form, resulting in the separation of α and β forms independently and finally appearing side by side; previously published photomicrographs illustrating this are reproduced. C. O. B.

1345. *The Copper-Nickel-Zinc Alloys.* **L. Guillet.** (Comptes Rendus, 170. pp. 460–462, Feb. 23, 1920.)—The nickel-brasses, with Cu as low as 40% and Ni up to 15%, show a max. stress from 45–75 kg./mm.^{2}, with elongations from 45–19%; they possess a colour from pale yellow to white, a resistance to oxidation comparable with that of the "nickel-silvers," and may be forged at high temperatures.

(I.) Cu 46·35%; Ni 10·35%; Zn 43·16%.

	Tensile Strength. Kg./mm^2.	Elongation. %.	Shock. Kg.-metres.	Hardness.
As cast	48·3	31	11	128
Rolled and annealed	56·6	45	13·2	137
Hard drawn	71·6	14	5	207

(II.) Cu 40·46%; Ni 12·86%; Zn 46·52%.

As cast	64·5	7	4·3	190
Rolled and annealed	60·8	18·5	7·8	170

(III.) Cu 45·48%; Ni 10·48%; Zn 40·58%; Pb 3·06%.

As cast	37·5	11·5	4·4	117
Rolled and annealed	51·8	45·5	9·4	126

The addition of 1–3% Pb to facilitate machining results in very marked improvement due to rolling and annealing. The transformation temperatures are:

Cu.	Zn.	Ni.	On heating.	On cooling.
60	40	—	445° and 780°	740° and 450°
55	45	—	445°	450°
46·35	43·16	10·35	66[illegible]° and 810°	760° and 6[illegible]0°
40·46	44·65	14·42	470° and 730°	730° and 375°
46	54	—	450°	450°
40	60	—	450°	350°

[See Abs. 528 (1913) and 1319 (1906).] F. C. T.

1346. *Physical Properties of Chromium Steels.* **T. Matsushita.** Tôhoku Univ. Sci. Reports, 9. pp. 243–250, June, 1920. Thirty-sixth Report of the Iron and Steel Research Inst.)—For alloys with 0·6% C and up to 20% Cr, the following values have been obtained for the thermal conductivity k and the electrical σ:

Cr %.	Slowly cooled from 900° C.		Quickly cooled from 1100° C.	
	k.	$\sigma \times 10^{-4}$.	k.	$\sigma \times 10^{-4}$
0	0·100	4·82	0·0981	4·82
0·5	0·0995	4·55	0·0886	4·46
1	0·0960	4·56	0·0882	4·38
2	0·0955	4·75	0·0870	4·36
3	0·0895	3·90	0·0575	2·82
5	0·0730	3·10	0·0445	2·23
10	0·0520	2·20	0·0386	1·95
15	0·0445	2·15	0·0334	1·66
20	0·0427	1·94	0·0310	1·57

The results are considered to be in agreement with those of Murakami [Abs. 491 (1919)] on the structure of these steels.

The moduli of elasticity and rigidity were:

Cr %.	Slowly cooled from 900° C.		Quickly cooled from 1100° C.	
	$E \times 10^{-12}$.	$n \times 10^{-11}$.	$B \times 10^{-12}$.	$n \times 10^{-11}$.
0	2·05	8·05	2·05	8·05
0·5	2·13	8·15	2·10	8·15
1	2·14	8·22	2·12	8·15
2	2·18	8·25	—	—
3	2·19	8·28	2·11	7·92
5	2·13	8·24	2·04	7·80
8·5	2·15	8·25	2·05	7·83
13	2·22	8·33	2·10	7·90
17	2·26	8·44	2·14	8·03

F. C. T.

1347. *Genesis of Ferrite.* **F. Giolitti.** (Chem. and Met. Eng. 22. pp. 737–739, April 21, 1920.)—Refers to the different crystalline habits of α and β iron, [see Abstract 1344 (1920)] and gives further evidence in support of the contention that in hyper-eutectoid steels the ferrite is not extruded as a shell to the outside of austenitic kernals, but exists as an aggregate of crystals essentially discontinuous and originating at the low-carbon nuclei of solid-solution grains. The microscopic structure of 0·6 carbon steel, after being heated to 900° and then cooled in a salt bath to temperatures varying by 10° between 750° and 700°, is given. At each of these temperatures a specimen was quenched in water and all 6 were then reheated to 575° to transform the martensite into sorbite. The pieces quenched at 730°, 720°, 710°, and 700° show a mesh-like structure of ferrite in increasing amounts, the ferrite having separated as isolated masses in the central regions of austenite crystals. This mode of formation is quite different from that shown by cementite in a hyper-eutectoid steel, which is extruded to a true meshwork at the crystalline boundaries. C. O. B.

1348. *Electro-Endosmosis and the Preparation of Solid Alkali Amalgams.* **S. B. Frank** and **J. R. Withrow.** (Am. Chem. Soc., J. 42. pp. 671–675, April, 1920.)—In previous work [see Abs. 929 (1907)] on Shepherd's method of making solid amalgams it had been noticed that electro-endosmosis occurred. The authors have made a further study of the subject and now show that the Shepherd device can be used as a lecture demonstration of electro-endosmosis when a good grade porous cup of about 40 × 80 mm. is used. The cup should be held by a clamp so that it visibly extends one cm. or less below the level of the anolyte, preferably saturated potassium sulphate solution contained in a beaker. The whole should be supported so that heat may be applied if necessary. A layer of mercury, 5 cm. deep, as kathode within the porous cup, is connected electrically by a platinum point protruding from the usual glass seal connection. To facilitate prompt action the cup may be soaked in a dilute solution of the electrolyte overnight, prior to the demonstration. Any form of platinum anode may be used in the beaker containing the anolyte. Twenty to twenty-five volts will suffice to enforce electro-endosmosis with the ordinary porous cup.

In the course of their experiments, the authors have obtained solid potassium and strontium amalgams. The preparation of a calcium amalgam was not satisfactory, either from aqueous solutions of calcium acetate, or from solutions of calcium bromide in ethyl alcohol or calcium chloride in methyl alcohol. The potassium and strontium amalgams were obtained from solutions of potassium chloride and strontium chloride (both saturated) respectively. T. S. P.

1349. *Use of Lead Electrodes in Thermochemical Measurements.* **C. Krahmer.** (Zeits. Elektrochem. 26. pp. 97–104, March, 1920.)—Satisfactory lead electrodes can be made by depositing lead on roughened Pt wires from a solution of lead silicofluoride. With such electrodes the e.m.f.'s, at varying temperatures, of the following cells were measured: $Pb \mid PbCl_2$ satd. $\mid Hg_2Cl_2 \mid Hg$; $Pb \mid PbCl_2$ satd. $\mid AgCl \mid Ag$; $Pb \mid PbBr_2$ satd. $\mid AgBr \mid Ag$; $Pb \mid PbI_2$ satd. $\mid AgI \mid Ag$. From the temperature coefficients of these cells the following heats of reaction, in calories, were calculated by the Gibbs-Helmholtz equation. (The most probable values of these heats of reaction, taking the results of the author and other experimenters [see Abs. 949 (1915), 590 (1917)] as basis, are given in brackets.) $\frac{1}{2} Pb + HgCl = \frac{1}{2} PbCl_2 + Hg$, 10,923 (10,900); $\frac{1}{2} Pb + AgCl = \frac{1}{2} PbCl_2 + Ag$, 12,225 (12,215); $\frac{1}{2} Pb + AgBr = \frac{1}{2} RbBr_2 + Ag$, 8982 (8982); $\frac{1}{2} Pb + AgI = \frac{1}{2} PbI_2 + Ag$, 5765 (5770). The heats of formation of the following compounds are calculated to be: $PbCl_2$, 85,491 (85,480); AgBr, 24,193 (24,193); AgI, 15,185, (15,170).

The e.m.f. of the cells above investigated gradually decreases, and experiments with evacuated cells of the type $Pb \mid PbCl_2$ satd. $\mid Hg_2Cl_2 \mid Hg$, showed that this decrease could not be ascribed to oxidation of the lead electrode. It is possible that the constancy of the electrode depends on a definite size of the lead crystals. T. S. P.